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THE COMMERCIAL VALUE OF WEATHER FORECASTS.

By E. B. Dunn.

THE severe storms and cold waves that have lately traversed our country, causing the loss of many lives, doing great damage to property, impeding railway and ocean traffic, and in fact bringing business to a standstill in many sections, affords an excellent opportunity to show the relationship between the United States Weather Bureau and the commercial interests of our country. The value of weather forecasts and special bulletins giving warning of the approach of hurricanes, cyclones, heavy snow storms, sleet, cold waves, frost, and warm waves is incalculable, and business men have not been slow in realizing the fact that to be forewarned is to be forearmed.

It was but a few years ago that the forecasts of the weather—or "probabilities," as they were then called—were scoffed at and made the occasion of much criticism. To-day they hold first place in point of importance in the daily press; they are read far and wide, and every man, woman, and child makes calculations accordingly.

There is no known science which has made such strides during the first twenty-five years of its existence as the science of the weather. When it is considered that less than twenty-five years ago the first attempt at forecasting the weather was made in this country, is it not wonderful,—the accuracy which has been attained, the verifications having reached almost ninety per cent.?

When forecasts were first made, they were general and for large sections of the country; for instance, the entire Atlantic coast was divided into three sections, the "New England, Middle, and South Atlantic States." To-day the forecasts are made for States and parts

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of States, and, in the commercial and business centres, for cities, which require closer attention to the exigencies of the occasion.

The lives, property, and money saved by the timely warning to our merchants of one severe storm or cold wave more than compensates the government for the maintenance of this important bureau. As soon as the approach of a storm is observed, or the development of one at any point with sufficient force to warrant apprehension of danger, warnings of its position, probable course, force, severity, and duration are telegraphed from the main office at Washington and the stations throughout the country in the path of the storm to all places and persons within the line of danger. The information is given to the press, bulletined in all post-offices, railway stations, exchanges, and many public and conspicuous places,—in fact, the warnings are disseminated in the best possible manner. For the benefit of mariners signals of warning—flags during the day and lanterns at night—are displayed along the Atlantic coast and on the great lakes. Mariners on the lakes, if not in a position to obtain information relative to storms, may apply by telegraph at government expense,—if on Lakes Erie or Ontario, to Observer at Buffalo ; if on Lakes Michigan, Huron, or Superior, to Observer at Chicago. Weather maps showing the daily atmospheric conditions, with storms and cold and warm waves outlined, are issued from all the larger stations throughout the country. Their appreciation may best be understood from the remarks of a captain of a Pacific mail steamship, who said : "I would as soon leave port without my clothing as without my weather map."

On the approach of the great West Indian cyclone, which swept northward along the Atlantic coast on February 12 and 13, 1894, special warnings were scattered far and wide ; the press associations and daily newspapers heralded the news so thoroughly that for 24 hours in advance the shipping interests along the coast from Florida to Maine were actively seeking a harbor of refuge, and for the first time on record not a vessel, not even the ocean liners, left port, so thoroughly was confidence placed in the warnings.

In commenting on this unprecedented fact, the maritime journals of the country said that the heeding of the warnings had undoubtedly been the means of saving millions of dollars and many lives.

The Honorable J. Sterling Morton, secretary of agriculture, in his annual report to Congress for 1894, states that "during the year much inquiry was elicited as to the probable value of the forecast work of the Weather Bureau. It is difficult to estimate with any degree of precision or accuracy the real value of the current work of the Weather Bureau. It, however, affects almost innumerable interests. It varies from day to day in its influence upon, protection over, and conservation of,

those multifarious interests. Directors of the State weather service in Ohio and North Carolina report—the first, a saving of $200,000 by the warning of January 24, 1894; the latter estimated that during the season $200,000 worth of farm products in his immediate territory was saved from frost by the same means. These estimates are conservative. They only hint at the vast possible value of these warnings.

"In January, 1894, the steamship 'Rappahannock' was stranded, and the nearest Weather Bureau observer, at Cape Henry, Va., immediately telegraphed a wrecking company at Norfolk to the effect that, unless the stranded steamer was lightened up enough to float at high tide on the night of the 24th, she would be broken to pieces on the rocks by a coming storm. The observer's message was communicated to the 'Rappahannock' by flag signals. This warning caused the wrecking company to exert themselves to the utmost, and they consequently discharged a sufficient cargo to enable the vessel to float that night at 10.35, and at 12.45 a. m. on the next day the vessel was floated out of danger, because of the Weather Bureau warnings. An intensely severe westerly and northerly gale (which had been forecasted) with freezing temperature, rain, and a heavy sea, set in, and it is generally conceded that, had the vessel continued aground until the storm struck her, she would have been pounded to pieces, and, with her cargo valued at $600,000, proved a total loss.

"The September tropical storm of 1894 was forecasted with great accuracy and exactness. Warnings were sent very generally along the Atlantic coast. Because of the admonitions of the Weather Bureau relative to that particular storm 1089 vessels, valued at $17,100,413, were retained in port.

"During the tropical storm of October, 1894, 1216 vessels, valued at $19,183,500, were prevented from going out to sea because of the warnings issued by the United States Weather Bureau. The value of the cargoes in all this multitude of ships which were prevented from encountering the tropical storms of September and October has not been estimated. It is, however, reasonable to presume that the cargoes were worth much more than the ships, and therefore safe to assume that the Weather Bureau warnings for the two months, which kept in port vessels valued in the aggregate at $36,283,913, also preserved from the perils of those most disastrous and far-sweeping storms several million dollars worth of merchandise, commodities, and other property in transit.

"Besides that vast amount of value in materials, many human lives undoubtedly were preserved from jeopardy and death.

"It is not practicable to estimate the value of the warnings to agriculture and inland commerce up to this time."

During the storm of September 27–30, 1894, there were held at anchor in the harbor of New York not less than two hundred and fifty vessels of all classes, from fishing smacks to the large ocean liners. But two made any attempt to leave port after the warning of the coming storm was given. When they reached Sandy Hook, one found she could not withstand the gale and returned to Sandy Hook bay; the other, unfortunately, was in charge of a foolhardy commander, willing to risk the lives of all on board and take all chances on the foundering of his vessel. He proceeded on his course only to suffer great damage. The decks of the vessel were swept, the mainmast was carried away, the second mate and one seaman washed overboard and lost, and the vessel arrived at its destination five days over-due, in a most crippled condition, while the vessels remaining in port in safety until after the storm put out to sea two days late, but had the assurance of a safe and comfortable passage. The filing of vessels out of port after the storm was an unusual and beautiful sight, which was commented upon in the daily press.

The secretary of agriculture, in another paragraph, states that "public appreciation of the warnings of the Weather Bureau and the growing importance attached to their value are very well illustrated in a recent suit against the Pennsylvania Railroad Company for the value of a canal boat wrecked during the storm of August 24-25, 1894. The lost boat broke loose from a Pennsylvania Railroad Company tug, by which it was being towed to South Amboy, N. J. In the progress of the trial Sergeant Dunn, (the writer) the Weather Bureau observer at New York city, testified that he had warned the public, including the railroad officials, of the approaching storm from Cape Hatteras. The question raised in the case is whether it is a legal duty of those having water-craft in their charge to respect Weather Bureau warnings. The decision of the court is awaited with intense curiosity, because it involves, to a certain extent, the value of Weather Bureau warnings. It all indicates that in the near future marine insurance may contain in every policy a proviso by which the insurance will become inoperative and void in case of loss by a storm against which the Weather Bureau shall have sent out timely warnings."

The railroad companies of the country are kept fully informed of the approach of heavy snow storms, sleet, and cold and warm waves. These conditions especially apply in their cases. If warning of heavy snow is given four or six hours in advance, they are enabled to get out and hold in readiness their snow-ploughs and crews; heavy trains are divided,—especially soft-coal trains, the coal absorbing an unusual amount of moisture and increasing the weight; shoots and switches are looked after to prevent them from freezing and being blocked with

snow; perishable freight is run under cover or hastened to its destination or held over; in fact, the advantages which the railroads enjoy by advance warnings are too numerous to recite.

Year by year, through the agency of the press and the various magazines, the general public have become enlightened as to the value of the Weather Bureau work. The daily observations showing weather conditions at all hours of the day or night form the basis of important evidence in many cases tried before the higher courts of the country. The supreme court of the United States decided in a case on appeal that the records of the Weather Bureau are competent evidence when produced in court or testified to by the observer in charge of records.

To further enhance the value of general warnings, one of the largest railroads of this country has in contemplation a system whereby it intends to coöperate with the United States Weather Bureau by having daily observations taken all along the line of its road. The utility of such a course has been pointed out by myself. In such a case the expense would be merely nominal in comparison to the advantages to be derived; for then the general atmospheric conditions, supplemented by the local observations, would enable the road to determine the advance of all atmospheric changes and keep track of the movement and passage of storms hour by hour; there would be fewer accidents through carelessness of engineers, for the accurate reports of wind velocity and pressure along the road would deprive such engineers of some of the false excuses which they now put forward. It could be readily determined whether or not a train destined for a certain point with perishable freight could accomplish the journey before being overtaken by the cold or storm, and whether it would be safe to start trains out on the approach of a storm. The road's entire system would be under complete control, and its managers would know just what to do and when to act in order to successfully combat the elements.

I expect to see, before many years, every railroad in this country taking systematic observations and coöperating with the United States Weather Bureau in this valuable work; it needs but a test to make it a permanent feature of railroading.

The warnings of freshets or floods along our great interior waterways are deserving of more than passing notice. These warnings have been the means of saving much property and many lives. The transportation companies along the line of the Mississippi are especially interested during the spring of the year, and eagerly seek the reports showing the height of the rivers and the prospective rise or fall.

The entire agricultural industries of the country receive as much benefit from the forecasts and warnings as the maritime interests. Extra precaution is taken to furnish full detail of coming changes during

planting and harvesting. The fruit and tobacco-growers receive the warnings of frost and cold waves; they do the most of their picking, packing, and shipping by and with the advice furnished by the Weather Bureau. Hardly a vessel containing a cargo of fruit or perishable goods enters the port of New York that the weather officer is not consulted before the hatches are opened and it is found whether or not the cargo can be discharged without risk of freezing. The business of the Cotton, Produce, and Mercantile Exchanges is governed almost entirely by weather changes. A rise or fall in the market may be the result of a cold wave, storm, or drought in the agricultural districts; consequently forecasts must be consulted to regulate buying or selling.

You may now ask the cause of the rapidly-increasing improvement in the weather-forecast work that has brought it to such a high standard of excellence. Such a question is easily answered by one who has spent the greater portion of his life in such work, and I can with great pride say that it is due to the untiring efforts of the Honorable J. Sterling Morton, secretary of agriculture, the only secretary ever in control of the Weather Bureau who gave this most valuable branch of government his personal attention. He has taken such an interest in the work as to inspire each man to renewed efforts. He has made a standard of excellence which none but those possessing the requisite qualifications can hope to attain. His promotions are made on the ground of merit. He conducts the affairs of the service on business principles; throws aside theory and places faith in practical work and common-sense methods. Such a system is developing its own reward.

The appropriation for the Weather Bureau for 1894 was $951,100; of this amount, $138,500 was turned back into the treasury, leaving the total expense at $812,711. This was accomplished by Secretary Morton, who gives more efficient service and improved forecasts with greatly reduced expense to the tax-payers.

From the establishment of the Weather Bureau up to July 1, 1891, it was under the control of the war department, and was conducted under military rule and form; its organization, however, was on a scientific basis and free from the contamination of politics. On the above date that part of the Bureau which dealt with the science of the weather was transferred by act of congress to the agricultural department, where it has since remained. At the time of transfer considerable fear was expressed lest politics should enter into the weather work and destroy its purely scientific character, thereby destroying public confidence in it. Seeing the threatened danger to this important branch of public service, Secretary Morton immediately took steps to have the entire service placed within the bounds of civil service, so that its usefulness might not be impaired, but increased.

ECONOMY IN RAILWAY OPERATION.

(FIRST PAPER.)

By L. F. Loree.

IT has been the fashion to designate epochs in the history of the human race by certain distinguishing characteristics, and so not infrequently we hear our own times spoken of as the age of steam. To be more specific, we might fitly call the century now closing the age of transportation. It was within this century that man's means of transportation first enabled him to exceed the speed of a fast horse, and the ability to so move himself and his belongings is working great changes in him and in his relations with his fellows. The strides with which the carrying-trade of the world has developed within the last generation are indicated by Munhall, who places the total railway mileage of the world at about 400,000, and estimates the total weight carried in 1892 at 1,746,000,000 tons. Along with this enormous growth in mileage and business handled has gone a reduction in charges that is equally remarkable, the average freight-rate for the world having fallen from 16 cents per ton-mile in 1850 to 2 cents in 1892. It is the purpose of this paper, and of one to follow it, to show in what ways this economy in railway operation has been effected and may be continued.

The most marked change in the direction of reducing general expenses has been in the consolidation of minor lines into great systems. This has been brought about by purchase and by lease, and has been pushed still further in certain directions by traffic agreements and traffic associations. Van Oss says that "in 1889 approximately 2450 minor lines had been merged into the thirty-three vast corporations to which nearly one-half of the American railways belong." The entire 167,000 miles were owned by 1705 companies, but the operations of these were controlled by 436 organizations. This has made possible a remarkable reduction in highly-paid officials, until, as has been shown by the *Railway Age*, 15 western companies, operating one-fourth of the mileage of the country and employing 170,657 men with a total pay-roll of $107,888,697, disburse in salaries of $5000 and over per annum $1,205,151, or $1\frac{1}{10}$ per cent.,—a proportion which is insignificant. It has also made possible the employment of the most highly-skilled experts, and the purchase of supplies in large quantities and on the most favorable terms,—the composition and quality of the supplies being secured by specifications and analysis through bureaus of in-

spection and tests, and in many cases the manufacturer's profits being saved through the maintenance by the companies of their own shops. The enlargement of control to cover large territories or diversified traffic permits of special economy in the use of the force and equipment. For example, during the summer and the season of navigation many of the engines and crews of the Chicago and Northwestern Railway are engaged in the transportation of iron ore from mines to the loading docks. The navigation season closes about the time the eastward movement of grain sets in, when this force is transferred to the company's lines further south. Thus much waste of energy is prevented and better service maintained. This tendency to consolidation still continues, and we may look to see much more accomplished. It is only within the last 3 years that the cars of the Pennsylvania Railroad have been pooled, and even yet the earnings and expenses have to be adjusted by book account. It is probable that the results of consolidation have not been more than half realized.

About the headquarters of the great companies gather many of the abuses incident to the existence of power: precedent and observance of form, sacrificing virility to system; a curious sort of contentment, and impatience of suggestions that seem to involve new methods or increased duties; nepotism (though to a less degree than would appear probable); and intrigue. Listen to Sir George Findlay's description of how things are done on the London and North Western Railway. "We will suppose, for example, that a goods agent conceives it to be necessary for an additional siding to be laid down at a station. He makes a report to that effect to the manager of the district; the latter inquires into the facts on the spot, and, if he concurs in the necessity, reports his recommendations to the general manager. The latter consults in the first instance the chief goods manager, or the superintendent of the line (general superintendent), as the case may be, and, if his report be favorable, authorizes the engineer to prepare a plan and estimate. The plan, when ready, is subjected to the criticism of the district officer, the chief officer, and the general manager, and, if all are satisfied, the directors are next asked to authorize the necessary outlay. But even this is not all, for finally the plan has to be signed by the chairman of the company before the engineer commences operations, and that gentleman, who keeps a watchful guard over the company's purse-strings, has to be convinced that the expenditure is not only desirable, but actually unavoidable, before his signature can be obtained. Thus the shareholders may rest perfectly easy in the assurance that their money is not dissipated in needless accommodation works." And all this without any recognition of the humor of the thing. Of course, it is conceivable that the mountain, after much

labor, may bring forth a mouse, but it hardly seems possible that the poor goods agent would ever venture on a second recommendation. The plan is not, however, without venerable precedent. It is said of the ancient Persian king that "the whole empire belonged to him, and all its inhabitants were his slaves. If he happened to be struck to the heart by a look cast from under a pair of black-edged eyelids, he had only to say the word; she was at once taken to the apartment of the women, and her parents received the congratulations of their friends. But then he was not allowed to see his beloved for a twelvemonth: six months she must be prepared with the oil of myrrh, six months with the sweet odors, before she was sufficiently purified and perfumed to receive the august embraces of the king, and to soothe a passion which meanwhile had ample time to cool." So we may well consider whether, however admirable the system may be for repressing the troublesome activities of subordinates, it may not prove equally effective in driving off valuable patrons, and preventing improvements in plant and practice.

The tendency is for general expenses to increase with disproportionate rapidity, and it has seemed impossible to effect any reduction in them. Not long since, in investigating the expenses of a road, I found that, under the stress of the 1893 panic, the expenses under other heads had been reduced $23\frac{1}{10}$ per cent., while the general expenses, after eliminating the item of taxes, showed an *increase* of $7\frac{1}{10}$ per cent. Is it possible that the courage that is remorseless in cutting down the forces when unacquainted with the persons affected falters when face to face with the responsibility? Or do departments claiming equal power hold each other in equilibrium, and prevent action? It is probable that here is to be found one of the most productive fields for the economy of the future.

MAINTENANCE OF WAY AND STRUCTURES.

No department has shown a more remarkable economy in recent years than has maintenance of way, whether tested by the expense per train-mile or by the expense per mile of railway. This improvement is largely due to the substitution of the steel rail for the iron rail formerly used, to the better drainage of the road-bed, and to the substitution of first-class ballast. Lardner says that, when the 35-lb. iron rails were laid down on the Louisville & Memphis, they were considered strong to superfluity, and were expected to last from 100 to 150 years; by 1873, through the deterioration in the quality of the rail and the heavy increase in the tonnage, they were wearing out on the Pennsylvania lines in from six months to two years. We are now gradually repeating with the steel rail our experience with the iron rail. Not only

is it impossible to secure in the modern fast-going mills that physical hardness formerly produced by cold finishing, but, as Mr. O. Chanute long ago pointed out, the pressure of the locomotive drivers approximates the ultimate crushing resistance of the metal. To the locomotive is due nearly all the destruction, and the rails are wearing out in from two to twelve years. It is possible that for a time we shall seek economy in a lower price, and there is considerable room for improvement in this direction. Steel rails are now quoted at $22 per ton; steel billets that require very little less work are selling at $17; it is possible, on this basis, for rails to sell at $18. But we must eventually seek to increase the rail in height and weight and to improve the material,—either by making the steel lower in carbon and tempering the rails in oil while at a dead red heat, by a proper arrangement of the cooling table, or by the substitution of nickel steel. Rails of this last material can be furnished at $70 per ton, or about what we were paying for iron when we abandoned its use.

MAINTENANCE OF EQUIPMENT.

The following table illustrates the economy effected in the United States in the matter of motive power:

1883-1885.	No. Locomotives.	No. per mile.	Average miles per Locomotive per month.
Continent	32,591	0.39	15,096
United Kingdom	14,200	0.76	18,362
United States	23,823	0.25	23,928
P. R. R.—1894	.....	.....	28,859

Mr. Evans claimed that "clearly the American locomotive with bogie truck and solid bar frame was the prime factor in economy" of American practice. Great improvements have been made in the construction of the machine. In 1840 the cost of working the locomotive per train mile in England was 37.32 cents; in 1845 this had fallen to 21.4 cents,—the decrease being due to the fact that "shortly after 1840 an essential improvement took place in the construction of engines by the introduction of the system of working steam expansively." The perfecting of the design and fit of the working parts has gone along with the simplification of the machine and the increase in its size and weight, until we now have an engine that is compact, durable, and well adapted to the work it must do. A further large reduction in the working expenses is due to the "first in, first out" system of running introduced on the Pennsylvania Railroad in 1878, by which fewer engines are used, greatly increased mileage is obtained from those in service, and the frequency of alternate heating and cooling incident to the "one man one engine" practice is much lessened.

There still remains a large mileage in this country where this system should be introduced; and where this is not practicable, the system of "link working" will still show an improvement. It is to be observed that the expense on account of fuel and stores exceeds the wages of the engine crew, and too much care cannot be taken to educate the crew in the economical use of these supplies. On many roads a "premium system" is in effect, by which the company divides with the men the savings above a specified maximum amount allowed for the run. This system, if properly followed up, is very productive of good results. The engine crews are, as a rule, a very superior class of men, with a good deal of pride in their business, and it is not a difficult thing to interest them in improved methods, if the matter is properly and clearly set before them. During the six summer months of 1894 we reduced the coal consumed per train mile 18 per cent. against the corresponding period of 1893, and the stores per 100 miles run by one-half. Within the last few years there has been a considerable construction of engines of the "compound" type, which makes it impossible for a careless engineer to run the engine as wastefully as he could run a simple engine. The advantage of the compound over the simple engine, in coal consumption when both are run to the best advantage, is perhaps 15 per cent. Much economy may also be effected in selecting the engine fuel, not only with regard to its steaming qualities, but with regard to its ability to stand handling and weathering. In few cases is the question of *quality*, as opposed to mere quantity, of greater importance. The item of water in the limestone regions is of great importance, not only because of the actual cost of furnishing it, but because of its destructive effects on the engine. At division points, or where large quantities are used, the filtering process, as practised on the London & North Western, or the precipitation by chemical action, as on the Midland at Derby, might be expected to show good results. Often a particularly bad lot of water may be avoided by changes permitting the removal of the tank to a different location. Few things will better repay study than a comparison of the analyses of the waters used on engines.

In the matter of stock carried the same reductions are possible as in the car department. By the use of up-to-date tools, and the convenient arrangement of the work and materials, considerable reductions can be made in the cost of repairs. By such means the cost of repairs on 170 engines averaging $926.61 each, at one shop during the past year, was reduced 10 1-2 per cent.

Secrist's Railway Equipment Guide gives the number of cars in use on American roads in 1894 as follows:

Common line and box	526,025

Dairy, dressed beef, beer and milk refrigerators	9,916
Furniture, barrel, chair and carriage	3,880
Ventilated fruit and heater	5,738
Stock cars	56,633
Flats and gondolas	554,588
Logging lumber and gun trucks	591
Oil and water tanks	2,371
	1,159,742
Cars privately owned, about	70,000

Mr. Wheatly gives the cost of repairs and renewals as $50,063,999, or about $40 per car. If our experience, showing that the relation of labor to material is as 1 to 0.75, is a fair average, then there is annually expended in labor $28,608,000 and in material $21,455,999. It was formerly the practice to carry stock on hand for making these repairs to approximately the value of one-half the total annual cost of repairs; hence the stock on hand must be worth in the neighborhood of $25,000,000. By a proper classification of material, working out of obsolete material, checking of supplies and orders, and prompt filling of requisitions (say within 30 days), the stock on hand can be reduced 50 per cent. without detriment to the work.

Recently the practice of working over the scraped material, and reusing it, has grown to considerable proportions. The extent to which this can be carried is indicated by the experience of a shop where, in making repairs to 30,217 freight cars, 81 2-10 per cent. of second-hand material was used. While this source of economy cannot be neglected, care must be taken that more money is not spent in reworking the old material than would purchase new.

The following table discloses one cause of the expense of repairs,—*viz.*, the want of standardizing of material.

BOX CARS IN USE IN UNITED STATES.

Length.	No.	Length.	No.	Length.	No.	Length.	No.
20 feet	275	28 feet	97,668	35 feet	7,079	42 feet	158
22 feet	33	29 feet	39,658	36 feet	10,057	43 feet	15
23 feet	84	30 feet	54,743	37 feet	2,393	44 feet	31
24 feet	995	31 feet	1,338	38 feet	1,639	45 feet	55
25 feet	478	32 feet	30,242	39 feet	957	46 feet	2
26 feet	514	33 feet	134,311	40 feet	5,157	47 feet	2
27 feet	3,615	34 feet	200,533	41 feet	150	48 feet	14

The capacities of these cars run from 20,000 lbs. to 60,000 lbs., and they have a probable value of $313,000,000. Besides increasing the expense of repairs, the old and low-capacity cars decrease the average movement, and make necessary an increase in the total number.

There is chance for economy, both in maintenance and operation, in a revision of this list.

There has been a very satisfactory progress of late years toward an adjustment of both the dimensions and the capacities of cars to needs of shippers. The gain in this direction, as well as over the English practice, is indicated by the following figures:

	Weight of car and load.	Weight of car.	Loaded car to empty.	Weight of car to average load.
United Kingdom....	8 tons.	5 tons.	1.6 to 1	1 to 0.3
U. S.				
1882	22½ tons.	10 tons.	2.13 to 1	1 to 0.7
1893	43 tons.	13 tons.	3.0 to 1	1 to 1.0

As Evans has pointed out, "large economies grow out of the American system of cars,—two four-wheeled bogies and chilled cast-iron disced wheels, the most economical wheel ever placed under a car." Further economy can be had in the use of supplies, systematic inspection resulting in reducing by one-half the amount of oil and waste. The grade of oil used on many roads is too expensive, comparatively cheap grades of earth-oils giving entire satisfaction.

The joint, notwithstanding all the efforts which have been expended upon it, still continues to be, as it was in the beginning, the weakest point in the structure. To increase the strength of the joint over the angle-bar form in common use, Dr. Alvin Vietor has invented a rail rolled with an unsymmetrical head, so that, when it is scarfed, the full strength of the web may be preserved; instead of entirely severing the rail at the joint, he maintains the full section of the head, and adds thereto two webs and angle bars deepened in their vertical section. But the most profitable field for present economy in this particular lies in the lengthening of the rail, and the consequent reduction in the number of joints. Modern cars permit of the convenient transportation of rails 33 ft. long, and that ought at once to be made the minimum length, thus reducing the number of joints by 10 per cent. Extensive experiments are being made with 60-ft. rail, and it is probable that this is the coming type.

Mr. Reece has shown that the cost of tie renewals, even in the well-timbered States of the Middle-west and North-west, has for some years past exceeded the expense on account of rail renewals. The time has come when we must try to devise some chemical treatment of the cross-tie which will protect it against the disintegrating effect of time and weather. The report of July, 1885, of the Committee of the American Society of Civil Engineers on the preservation of timber, holds out the hope that by Burnettizing we may double the life of the

tie. Some three million ties have been so treated on the Chicago, Rock Island & Pacific and Atchison, Topeka & Santa Fé roads, the cost being about 17 cents per tie, or, by the improved Wellhouse process, 19 cents. Against the abrading action of the rail moving under the traffic we may interpose the protection of the tie-plate, the flanges of which, imbedding themselves in the wood in the direction of its fibre, will become an integral part of it, and will enable us to substitute for white oak less expensive woods.

There can be no doubt that, as Mr. Wm. H. Brown suggests, "the cheapest way to operate a railroad is to keep the track in first-class condition all the time." Mr. Dorsey concludes that the average American road can profitably invest $13,167 per mile to improve its road-bed and track so as to operate as cheaply as the English roads with regard to maintenance of way, locomotive power, and repairs to passenger and freight cars. He finds that from 1876 to 1885 there was a decrease of 118 per cent. in materials used on five English lines representing 50 per cent. of the business, and attributes our excessive cost of maintenance to the great amount of perishable materials used, the excessive cost of labor, and the severe winter weather. He calls attention to the small amount of material used on the London and North Western in 1886,—$245,000 against $895,000 in wages, or, say, 1 to 3.65,—and says that English wages are 50 per cent. lower than ours. Their material is perhaps 25 per cent. cheaper, which would change the ratio to 1 to 5.87. It is not possible to get similar figures from the published accounts of American roads, but an analysis of the expenses on my own division for 1892—an average year—gives wages 1, material 1.13. The difference is so great as to throw doubt on the correctness of the figures furnished, but unquestionably our expense on account of material is excessive. The high price and large amount of labor would indicate this as a field promising immediate results, and we find it being vigorously attacked in many quarters. The great success that has attended the piece-work system in locomotive and car repairs has naturally suggested its application to maintenance-of-way work; the large proportion of labor devoted to surfacing track and the relatively small number of "pieces" of work make its success very promising. Trials have been made in Austria and Belgium with but indifferent results, but those being made in this country promise a fair degree of success.

Great care should be taken to sharpen the eyes, and sense of neatness and good looks, of the entire force. Not only is the feeling of self-respect and well-being greatly increased in the employee, but the work is much more carefully done, and there is much less waste of material.

The want of a unit of comparison is felt in considering this class of expense. We measure the oil used in the lubrication of cars by the "thousand miles" run, we measure the cost of locomotive fuel by the ton mile, but we have no standard of comparison for maintenance-of-way expenses. I have seen no suggestion that seems to me an improvement over the method used by Lardner in 1848, which divides the expenses into two parts: (1) those which are appropriate to the repairs of the wear and damage produced by time and the vicissitudes of weather; (2) those which are appropriate to the repairs of the wear and damage produced by the action of the traffic upon the road. Such an analysis of the expenses of two divisions for 1892 gives the following results:

EXPENSES DUE TO TIME AND THE WEATHER.

	Per Mile of Main Track.	Per Mile all Track.
Line A	$1035.00	$607.64
Line B	603.65	380.15

EXPENSES DUE TO TRAFFIC.

	Per Train Mile.	Per Ton Mile.
Line A	$0.139	$0.0004
Line B	0.080	0.0004

Such a comparison might well invite inquiry on the part of the management as to the administration on line A in the items of fences, cattle-guards and road-crossings, bridges, cross-ties, road-bed, ballast, etc.

Under this head may also be mentioned the advisability of eliminating so far as possible the crossings of railroads at grade. Not only do these crossings seriously affect the speed of passenger trains, but they are costly to maintain and operate, and introduce new elements of danger. Here also we may well take account of the rapid increase of grade-crossings of electric railways, the dangers from which have become so threatening that the directors of the Pennsylvania Railroad, in their last annual report, say "they create a new and most serious peril for the traveling public. It must be borne in mind that the entire movement on these electric railways is in the transportation of passengers, and that therefore the risk of life and limb from such crossings, owing to the frequent service, is proportionately much greater than on the steam railways, where the trains are not nearly so frequent, and where the movement is made up largely of freight traffic. It would hardly seem reasonable that the electric railways should be permitted to indefinitely increase the number of crossings, while at the same time your company and the city of Philadelphia are expending over

$400,000 to remove grade-crossings on your road by the North Pennsylvania Railroad in the northern portion of the city."

Considerable economy in operating the traffic can sometimes be effected by changing the location of passing sidings so as to get the benefit of momentum in overcoming adverse grades; stations or telegraph offices often are so located that trains have to back up and take a run for the hill, which they could without difficulty have surmounted under headway. Very often this results in decreasing the train load. Sometimes a change in the rules for taking sidings will overcome the disadvantage of location, but, if necessary, the change in the sidings themselves is usually inexpensive. On a road 100 miles in length with 0.80 maximum grades in average broken country the cost of relocating the passing sidings was $30,000. Of much greater importance is the question of the reduction of the ruling grades, which bids fair to occupy a very prominent position in the economy of the future. Mr. Wellington has pointed out that, "by attacking the work of improving old lines by the method outlined in his work on 'Economic Location,' halving the more formidable and inevitable grades at once by using a pusher on them and spending all our money on what were before the very easy grades and hence are usually in light work, the average train load may be doubled, at small cost, on thousands of miles in this country." More recently Mr. Thompson has shown that the money spent in improvement of track, strengthening of bridges, etc., with that spent in getting heavier engines, if used in the reduction of grades would have produced about the same results in increasing the train load. It seems entirely probable that all the enormous economy growing out of the use of heavier engines will be duplicated in the future at approximately the same cost by the reduction of grades.

WATER POWERS OF THE WESTERN STATES.

By A. G. Allan.

WHILE the subject of irrigation may be the most important issue now before the people of the Western States, the development of the magnificent water powers which nature has so bountifully supplied, and the transmission of that cheap power to localities where it can be used in manufacturing, will, before very long, become the primary object in those industrial circles.

There being comparatively few places in the West where coal is mined, the manufacturer of the Western States, using steam power, can never, except in a few favored localities, compete successfully with the factories of the States east of the Missouri, using cheap and easily obtainable coal. The inhabitants of the "arid regions" now consume many articles made in eastern factories from raw materials grown by themselves.

Owners of waterfalls are beginning to realize that this class of property has been largely advancing in value in the past few years. Nevertheless there are yet many opportunities in the Western States for the advantageous acquirement of important water-power privileges.

There are to-day hundreds of thousands of horse power running to waste in the Rocky Mountain rivers and streams, because of their remoteness from centers where the power can be utilized; but, when the question of long-distance transmission of energy by means of electricity shall have been solved,—and in the opinion of electrical experts this is nearly accomplished,—the owners of water powers will use this now wasted force to turn the hundreds of wheels in mills and factories in manufacturing cities, which are now entirely dependent on steam.

An Eastern man lately remarked to the writer: "I do not consider water power so much cheaper than steam power; the waterfall must belong to some one, and, as soon as the owner can obtain a rent for it, he will charge so high a rent that it may just pay the manufacturer to use his water instead of steam power." This might apply to localities in the East where coal is mined in many places over a large area, but the order of things is reversed where coal is expensive and water power plentiful. Property has not the same value in a thinly-settled region that it has in a populous country, and there are many isolated mines and mills (of which two will be shown later) where one year's saving in coal, in consequence of the use of water power, has repaid the entire outlay on the hydraulic installation.

All through the West the smaller water powers have been gradually

RAINBOW FALLS, GREAT FALLS, MONTANA

FALLS OF THE WILLAMETTE, OREGON CITY.

THE FALLS OF JUANACATLAN.

developed to drive flouring mills and electric-lighting plants, as well as to furnish power for some mines. But not one hundredth part of the available water power now wasting its energy is caught and made to do the work which it is capable of doing. In a newly-settled country the smaller powers are always developed first: usually by individuals for their own use, by building log or earth dams across narrow streams, with short races, and cheap wooden gates and penstocks; then gradually by capitalists and corporations, who construct larger and more substantial works as soon as the demand for power will justify the expense.

These rivers originating in the mountains, where the precipitation is large, and flowing from a high altitude to a gently-rolling plain, in a comparatively short distance the river channels form two distinctly different characteristics. The mountainous portion being rocky, the rivers run at a high rate of velocity on a steep grade, through deep, narrow cañons, until they reach the broader valleys below, when they change into wide, shallow, and usually sandy streams. Farming west of the one-hundredth meridian depends for success entirely upon irrigation, the rainfall being insufficient to mature crops, and the amount of arable land being largely in excess of the supply of water. In Colorado, where almost the entire flow is taken from the Platte and

Arkansas rivers and their respective tributaries in the irrigating season, there are, with few exceptions, no large water powers outside of the mountain region. Nebraska is 440 miles long at its greatest length, and 207 miles wide. It is one vast prairie, with an elevation of 5000 ft. above sea level on its western border: it is intersected with about seventy-five rivers and small streams and thirty-four small lakes. The largest river is the Platte, which has a total length of 1200 miles; it is formed by two branches,—the North and South Platte,—their junction being at the town of North Platte in the center of the State. The South Platte has a drainage basin of 24,400 square miles, but, except during a short time in the spring and early summer, no water reaches its mouth, the entire flow being absorbed by irrigation. Therefore all water for power purposes in Nebraska comes from the North Platte. This river, heading in the Colorado North Park, has a computed drainage basin of 35,500 square miles, with a fall at first of nearly 12 ft. to the mile, gradually reduced to 6.9 at North Platte. The only large developed power plants are at Gothenburg and Kearney, respectively 40 and 100 miles east of North Platte.

The plant at Gothenburg consists of a canal 11 miles long, with a fall of 1 ft. to the mile: the river here having a fall of 6.6 ft. to the mile, the available head obtained is 50 ft., and the maximum h. p. 2500. The plant is equipped with a pair of 22½-in. horizontal

WASTE WEIR AT KEARNEY, NEB.

water wheels, and dynamos sufficient to generate electricity for lighting purposes.

The power at Kearney is obtained by means of a canal 16½ miles long, with a fall of 1½ ft. to the mile. The river, falling 7.7 ft. to the mile, gives a head of 60 ft. at the end of the canal, where a large brick power-house is located, furnished with two pairs of horizontal water wheels, a large Corliss engine and boilers, and eight dynamos. The power is utilized to light the city, generating current for thirty arc lights and about two thousand incandescent lights, as well as to furnish the motive power for a large roller flouring mill, two foundries, printing establishments, and numerous small motors. Two miles above the power-house the canal furnishes power for a 15,000-spindle cotton mill, driven by a pair of 35-in. wheels under a head of 35 ft.

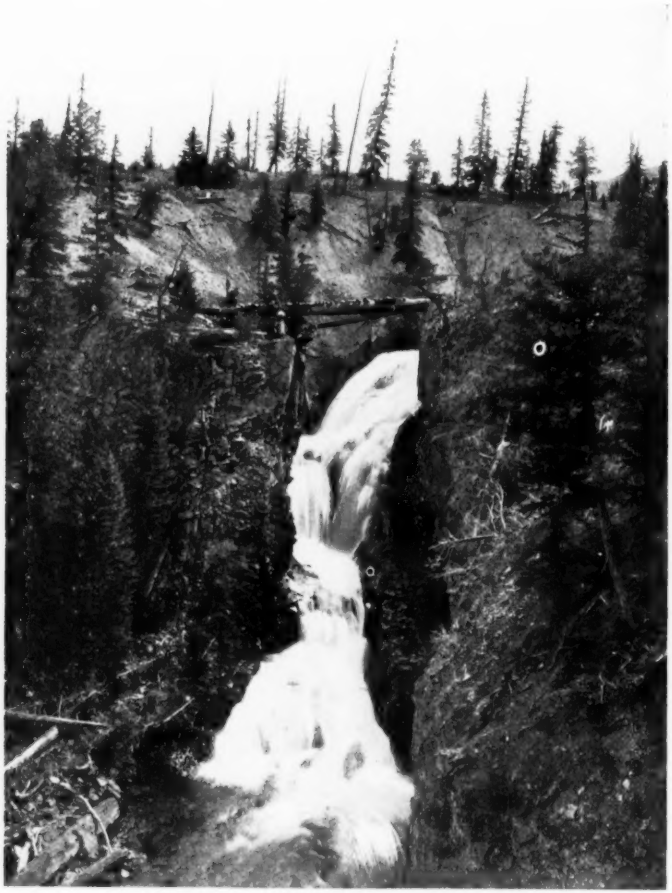
There is nothing peculiar in either of these powers, which are due simply to a difference of grade between the canals and the river. The great difficulty is to divert the requisite amount of water into a canal from such a wide shallow river as the Platte, whose currents are changed from one side to the other by high winds, and whose sandy bed absorbs so much water that the visible supply for this great river, draining 60,000 square miles, falls as low as 800 cu. ft. per second.

Coal for steaming purposes costs $3.50 per ton; so, assuming 1 h. p. to be developed from 4 lbs. of coal per hour, the annual cost per h. p. would be $70 for a 100-h. p. engine working 310 days 24 hours per day. A canal, costing $200,000 and furnishing daily 5000 h. p. for 24 hours, would pay a good dividend daily at $1.00 per h. p. per annum for each hour that power would be used, making power cost $24 per annum for 24 hours daily use, or $10 per annum for a 10-hour daily run, if industries to consume the available power were established.

The city of Omaha has an incorporated water-power company, which has surveyed a canal 40 miles in length, with a capacity of 1500 cu. ft. per second, carrying this to a point a few miles west of the city and giving an available head of 140 ft., and about 15,000 h. p. As Omaha is a manufacturing city of considerable prominence, with a population of 140,000, this power plant will sooner or later be constructed.

A typical prairie mill power is located at C——. This, consisting of a cheap log and earth dam, with a timber over-flow, diverts the water into a race about a quarter of a mile long; the wheel used is a vertical turbine, set in a wooden penstock, while the power is conveyed to the mill by wire cable. The head obtained is 13 ft., and the mill uses about 40 h. p. Nine out of ten men would not consider the plant of any commercial value, although in reality it has proved a splendid investment. The cost of operating this small mill by steam would be

BEAR CREEK FALLS, NEAR OURAY.

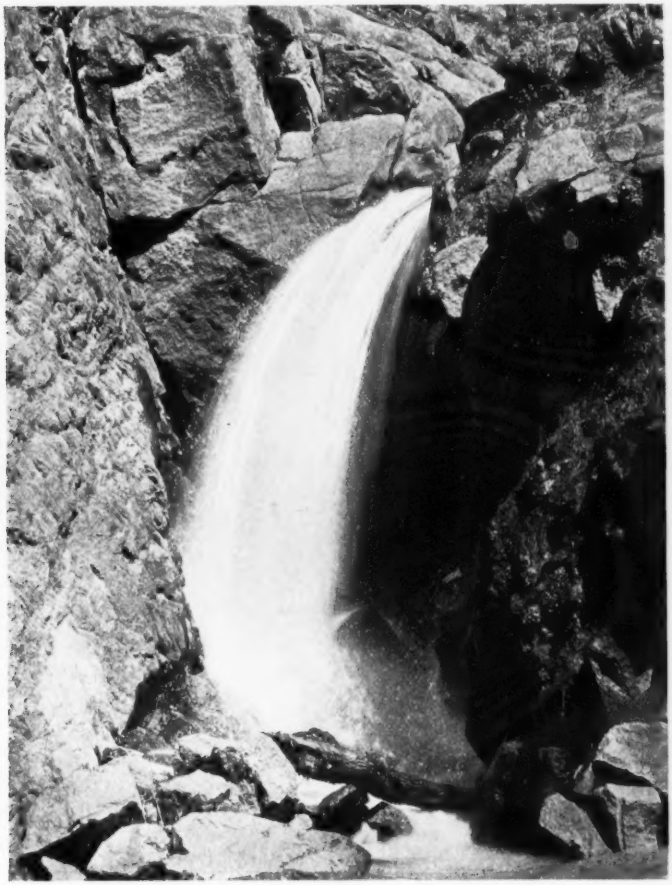


ARGENTA FALLS.

at least $2000 per annum. It is doubtful whether the water plant, including the dam, cost more than this amount for the first outlay; and, with an annual repair bill of one tenth, it runs continuously, day and night.

North and South Dakota are comparatively level, the only range of mountains being the Black Hills. Their elevation is between 1500 and 2500 ft. above sea level, except at the Black Hills, where the eleva-

tion ranges from 3000 to 7000 ft. The principal river is the Missouri, which runs through the two States with a general south-easterly course; its fall is only .76 ft. per mile, and consequently the river cannot be utilized for power purposes. The Red river also runs at a low rate of velocity. The James river, a tributary of the Missouri from the north, is about 340 miles long, and has an average fall of 3 ft. to the mile, furnishing plenty of water power. The Big Sioux, rising in the eastern



CAÑON CREEK FALLS.

CASCADE NEAR SILVERTON.

PROOD FALLS, UTAH.

part of South Dakota, forms the boundary line between that State and Iowa for some distance. It is a rapid river, furnishing many small powers along its course, and at Sioux Falls it drops 110 ft. in one mile, furnishing power there for several flouring mills.

There is another source of power in South Dakota, which is peculiar to itself,—*viz.*, artesian wells. The United States Geological Survey shows that under the valleys of the Missouri, as far east as the divide of the James river, there exists the largest artesian basin in the world. The stratum in which the water is found out-crops in the beds of both the Yellowstone and Missouri rivers at the base of the Rocky Mountains, and follows them down until released by the Dakota wells. The difference in the elevation accounts for the high pressure in these wells, which varies from 50 to 200 lbs. to the sq. in. There are now in working operation two electric-lighting plants and ten flouring mills, all propelled by this power. It is a question whether increasing the number of wells will not lessen the pressure, but at present it has not materially done so.

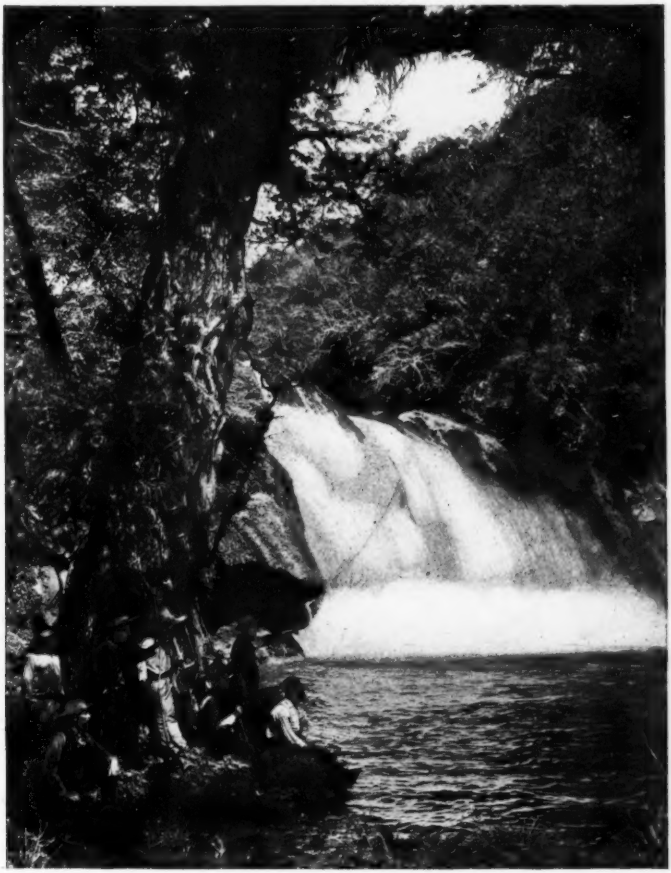
Flour milling is the chief manufacturing industry, the last census giving North Dakota thirty-five mills and South Dakota sixty-two. On account of the high price of coal for steam purposes, these wells are very profitable. The methods of utilizing them are very similar. The water wheel, in an iron casing, is screwed to the pipe which forms the curbing of the well, the volume and pressure being controlled by valves, and the water exhausting into a ditch in which it is drained off. At Northville the water is applied through a 1½-in. nozzle under a pressure of about 100 lbs. to the sq. in. The wheel used is a Pelton, 4 ft. in diameter, with 6-inch buckets bolted to the rim, which drives a full roller-process flouring mill of 100 bbls. capacity. Other wells of the same character are at Yankton, Armour, and Woonsocket.

Colorado contains 104,500 square miles, of which about 32,000 square miles, forming the central portion, are mountainous. It is the highest of the Western States, having a mean elevation of about 7000 ft.; four-fifths of its area is estimated to be between 4000 and 10,000 feet above sea level. The Platte and Arkansas rivers have their sources in the mountains of this State, draining to the East; the Rio Grande drains to the South; while on the West the State is drained by the Grand, Gunnison, Dolores, White, and Uncompahgre, with their innumerable smaller rivers and streams.

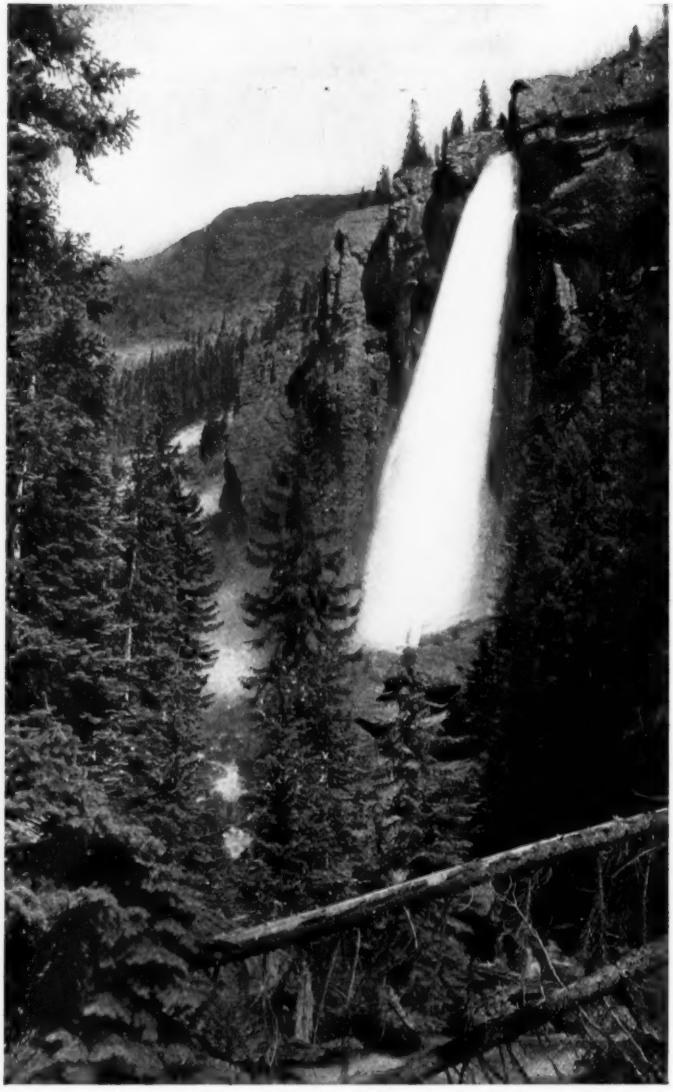
In the mountain regions the water powers, remarkable for the very high heads obtained, are usually taken from small streams, or "creeks," as they are called, just before their junction with the larger rivers. One at Telluride has a head of 850 ft.; others near have 320, 425, 500, and 600 ft. These plants are all used for generating elec-

tric currents, which are transmitted from 3 to 10 miles, driving motors for mining purposes, and are operated without intermission. Another near Ouray has a head of 485 ft.; the water is taken from a cañon creek and carried in an iron pipe 4000 ft. long to two wheels, developing about 1300 h. p.

The excessive cost of operating isolated mines at high altitudes by steam power—the coal having often to be packed on the backs of bur-



FALLS OF THE ABRA.



BRIDAL VEIL FALLS.

ros, which makes it cost nearly a cent per lb.—has led mine-owners to develop these water powers, and transmit by electricity to motors at the shafts, the saving in cost of operating being in some cases as much as $40,000 per annum.

At Aspen the electric light company uses eight wheels, giving 1400 h. p. under a head of 820 ft. The water is brought to the power-house in a supply pipe from 14 to 16 in. in diameter. The entire power is used for operating motors at various mines within four miles from the station, and for lighting the town. Under the conditions just described—*viz.*, small volume of water under very high heads—the Pelton wheel seems to be the favorite. There are two other power stations in this vicinity, one using water under heads of 312 and 330 ft., the other having 750 h. p. under a 180-ft. head. At Glenwood Springs one company has a head of 470 ft., the power being utilized to light the town.

A company has lately been incorporated to develop a water power at Clear Creek, transmitting the power to Denver. There is no doubt that some far seeing men will eventually furnish the metropolis of the State with cheaper power. There are in Denver flouring mills, rolling mills, foundries, immense smelters, machine shops, cotton and woolen mills, shoe factories, glass works, carriage and harness factories, paint works, breweries, and cable-line, electric-car, and electric-lighting companies, all using steam power at a cost, approximately, of $40 per h. p. per annum, depending on the size of the plant and number of hours run, when there is enough water power in the mountains west of the city to run every factory located there at a considerably less cost per horse power, and leave a profit for a water-power company.

One of the best rivers for large power development is the Grand, the main tributary of the Colorado in this State. It is the largest river in the State; heading in the Middle Park, it cuts its way to the West at right angles with the main mountain ranges, and consequently flows at the bottom of nearly one long cañon, from its source to its junction with the Green. It rises 8150 ft. above sea level, and joins the Green river in Utah at 3900 ft., having fallen 4250 ft. in 350 miles, with a discharge of over 5000 cu. ft. per second. There must be 2,000,000 h. p. going to waste in this river alone. Is it any wonder that the river has cut cañons 2000 ft. deep? Development of water powers is only beginning in Colorado, having been carried out only where the price of coal for steaming purposes has compelled users to seek some cheaper power.

Montana is without doubt the best-watered State in the West, having the Missouri and Yellowstone rivers, with their vast number of

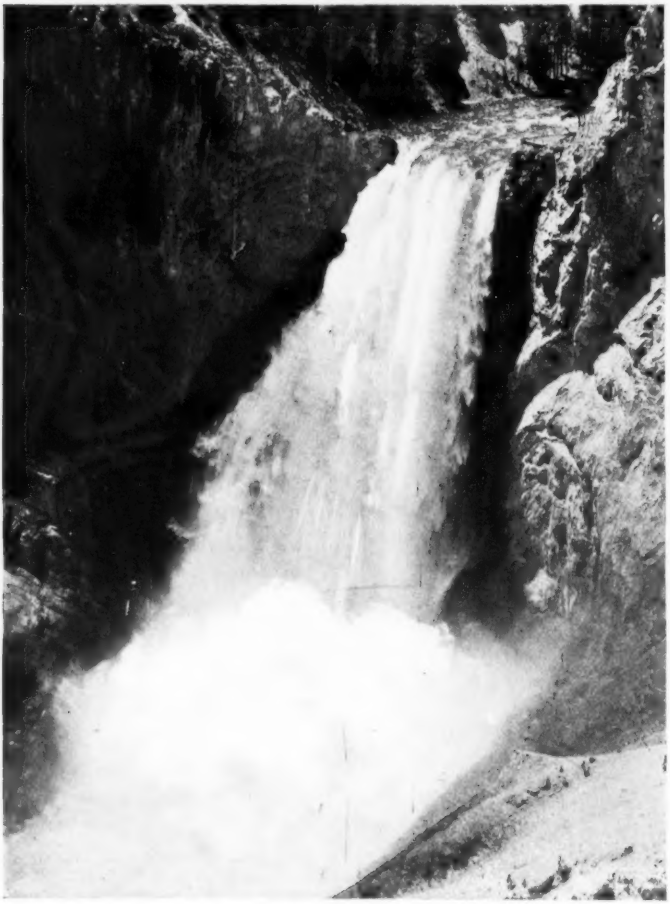
large and small tributaries, within its borders. The State is comprised of two parts, the western being mountainous, while the eastern is a rolling plain rising from 2000 ft. at the Dakota line to 4000 ft. at the base of the mountains. The Missouri, heading in the mountains at a high altitude, has a water-shed above the mouth of the Yellowstone of 95,000 square miles. Its principal mountain tributaries are the Madison, Jefferson, and Gallatin, while the Milk and Musselshell join further down, each fed by hundreds of smaller streams. The largest power developed on the Missouri is at Great Falls, where the river runs into a deep gorge with rocky sides, falling here 512 ft. in a distance of 10 miles. The minimum discharge is 1800 cu. ft. per second. A dam and head works costing $275,000 have been built across the Black Eagle Falls, 3 miles from the city, and power-houses costing $150,000 are in operation, furnishing mechanical power, transmitted by cable, to a number of mills and factories. The Rainbow Falls are at present undeveloped, but will soon be used as a motive power for smelting and refining plants. The available h. p. at this point is set at 268,000. The largest smelter located there uses nine single and double wheels from 20 to 48 in. in diameter. The power is transmitted by cables 2100 ft. to the smelter and refinery. Another company uses three pairs of wheels under 40 ft. head. The power obtained is used for electric lighting and for an electric railway 14 miles long, as well as for many smaller motors distributed throughout the city.

The Yellowstone, heading in the National Park (its source being in the Yellowstone lake at an altitude of 7740 ft. above sea level), has a drainage area of 69,600 square miles, and runs for the first 100 miles, after leaving the Park, in a gorge from 350 to 650 ft. below the level of the ground. Its capacity for power purposes is almost unlimited.

Crossing the mountain ranges to the West, we come to Idaho, which lies within the area of the Pacific drainage, only the south-eastern portion draining to the Great Salt Lake Basin. The northern part is very mountainous and covered with timber. The southern is, in general, an arid plain with a comparatively level surface, through which the Snake river has its course. This is the principal river in the State, heading in the Yellowstone Park in Wyoming (where the snow fall is from 5 to 10 ft. deep on the level) and flowing through a deep gorge or cañon, with sides too steep to allow use of the water for irrigation. It is one of the most remarkable rivers in the West. It has a fall of about 4500 ft. from the junction of its North and South forks to its union with the Columbia in Washington, in an alternation, throughout its length, of gently-flowing sections with tremendous rapids and cascades. It falls 50 ft. at the American Falls and 90 ft. at

THE GREAT FALLS OF THE MISSOURI.

the Twin Falls, and, 3 miles below this, at the Great Shoshone Falls it makes a drop of 310 ft. The discharge, as measured by the United States Geological Survey at Eagle Rock (drainage area 10,100 square miles) is a maximum of 50,000 cu. ft. and a mimimum of 4000 cu. ft. per second. It has some large tributaries, of which the principal are the Portneuf, Blackfoot, Boise, Weiser, Payette, Salmon, Owyhee, and

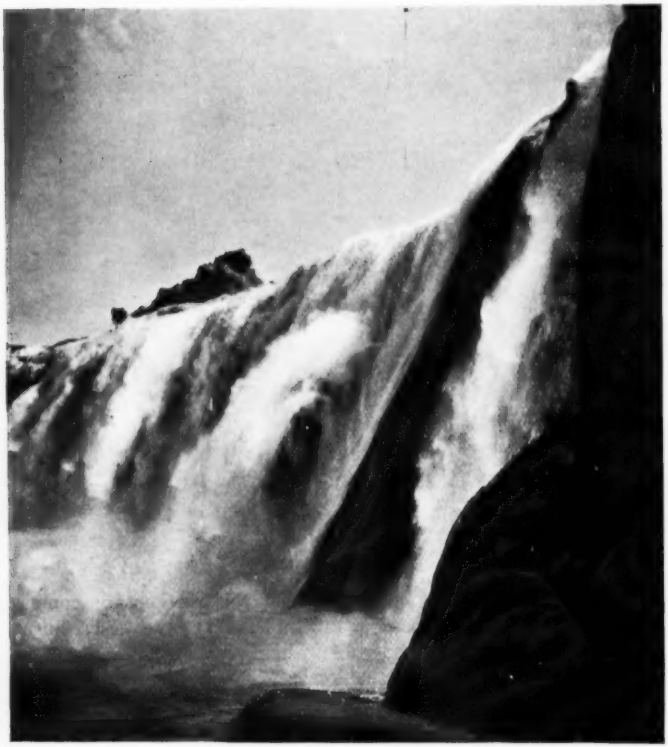


LOWER FALLS OF THE YELLOWSTONE.

SHOSHONE FALLS.

Bruneau. The water powers throughout this section are confined principally to isolated mines and saw mills, one of the best being at Boise City, where a plant under 62 ft. head drives a flouring mill and furnishes the power to light the town. The northern part has some splendid water powers. In the Cœur d'Alene district we find the small cañon creeks, under high heads, developed for mining enterprises. The plant of the Cœur d'Alene Mining Company, near Burke, consists of a flume over 2 miles long, with a pipe line of 15- and 18-inch pipe 3000 ft. long, supplying water to two wheels giving 750 h. p. under 800 ft. head. Other power plants in the locality have 520, 700, and 800 ft. head. The saving in fuel effected in using electricity generated by water power instead of steam has exceeded in some cases, in this locality, $100 per day. In the country draining to the Great Salt Lake Basin there are not as many water powers outside of the mountains as are found on the eastern slope of the Rocky Mountain range, all water being appropriated for irrigation, and the sections where there is any water being thickly settled.

Wyoming has a mean elevation of 6400 ft. above sea level, and contains the Rocky Mountain range passing north from Colorado, part of the Black Hills, the Big Horn Mountains, the Laramie and Wind



SHOSHONE FALLS.

River range, and others. This mountain area is estimated to be, approximately, 35,000 square miles, on which there is an average annual precipitation of 36 in. of water. There are three hundred rivers and creeks within the State. The principal are: on the east slope, the Platte; on the west, the Snake and Green; on the north, draining to the Yellowstone, the Powder and Big Horn, with their respective tributaries. All the streams east and west of the Big Horn Mountains are rapid and not liable to variable extremes. The fall per mile is large, and this section has some fine water powers used for mining and saw mills; but it is sparsely settled, lies at a high altitude, and is practically destitute of railroad facilities.

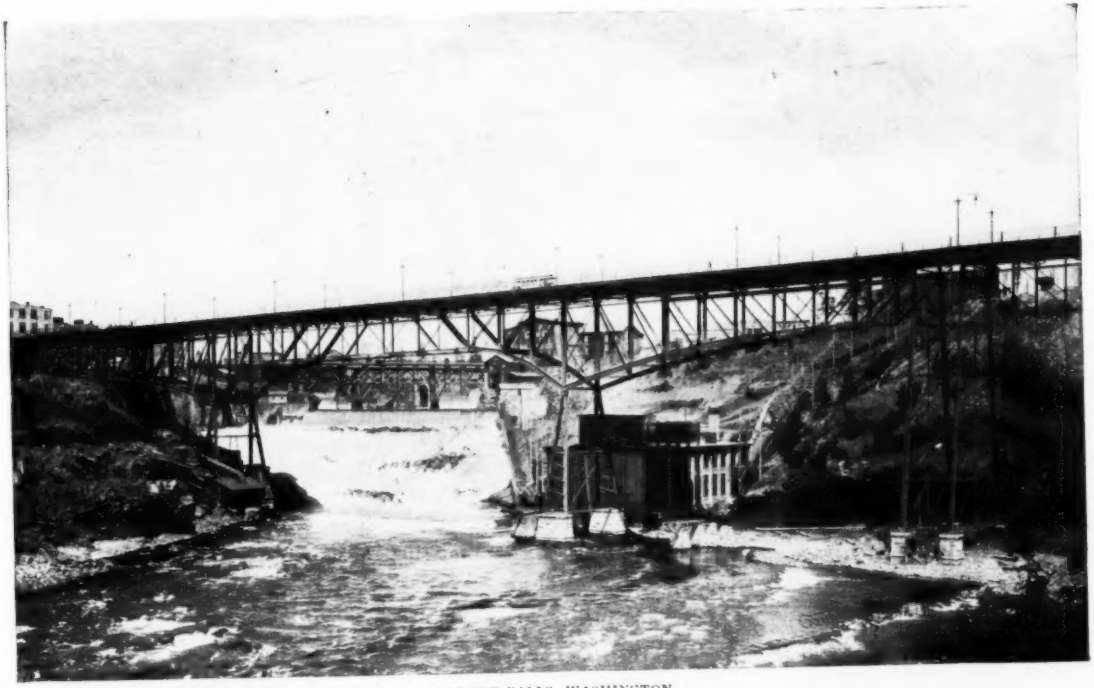
Washington, with its many diversified industries and climates, is

divided from North to South by the Cascade Mountains, which range from 6000 to 10,000 ft. above sea level. As the snow-fall on the mountains is large, and the annual rain-fall is from 70 to 120 in. on the coast, the amount of available h. p. wasted in the rivers draining to the Columbia is almost unlimited. The largest power developed at present is at Spokane Falls, where the Spokane river, leaving the higher ground for the valley of the Columbia, tumbles in a succession of falls 157 ft. in half a mile. Every mill and factory located there, including the water-works company and cable railway, propel their machinery with this magnificent power. It is estimated that to furnish the power available and in use at this city by steam would cost $4,000,000 per annum.

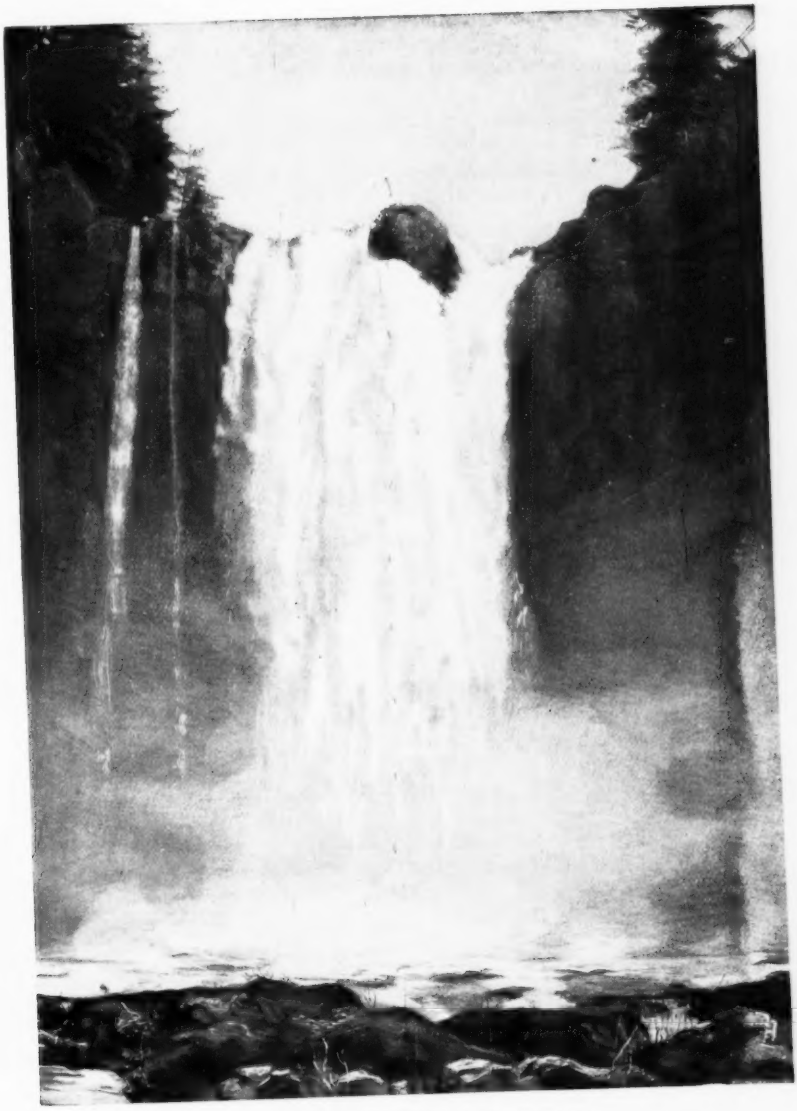
A company has bought, and is preparing to utilize, Snoqualmie Falls, 23 miles east of Seattle, to furnish electric power to that city and Tacoma, and smaller adjacent towns. The height of these falls is 268 ft., and the energy is estimated at 51,600 h. p. Seattle and Tacoma have a number of different manufacturing establishments and cable, electric car, and electric-lighting companies, all dependent on steam. The two cities use about 10,000 h. p. at a cost of $60 per h. p. per annum, while the city of Everett consumes 1500 h. p. at an approximate cost of $65. If electricity generated by this water power was used instead of steam, it would result in a saving of at least $300,000 per annum to consumers.

Oregon, like Washington, is divided by the Cascade range, which has an average breadth in the State of between 50 and 60 miles, with an approximate height of 8000 ft. The annual rainfall on the Pacific side of the mountains is between 50 and 67 in., by far the larger proportion falling in the winter season. The principal rivers are the Willamette, Yamhill, Umpua, and Rogue on the west side of the mountains, with the Des Chutes and John Day on the east. The largest power developed is on the Willamette at Oregon City, fifteen miles from Portland, where the river has a fall of 40 ft. A power-station has been built, equipped in twenty sections, each section having a large dynamo coupled directly to a 42-inch Victor wheel, with a 60-inch wheel for emergency uses in periods when the river backs water. The total energy obtained is about 12,000 h. p., and the amount of water used is about 5000 cu. ft. per second. The power is transmitted to the city of Portland, being used principally for street-car propulsion, including an electric railway to Oregon City. It would be impossible to enumerate the available water powers in this section of country close to the Columbia. The writer has seen three mills, each using heads of over 25 ft., one below the other on the same creek, only a few hundred yards apart.

The great mountain range of California is the Sierra Nevada, some



SPOKANE FALLS, WASHINGTON.



SNOQUALMIE FALLS, STATE OF WASHINGTON.

of its peaks reaching heights between 13,000 and 14,000 ft. above sea level, while the coast range varies from 6000 to 8000 ft. in the northern part, decreasing to hills in the southern. The average snow-fall, being from 60 to 70 ft., gives, at the ratio of 11 ft. of snow to 1 ft. of water, from 5 to 6 ft. of water over an area of 6400 square miles, at a height of more than 8000 ft. above sea level. The rivers, highly developed for power purposes, have their source in this great Sierra Nevada chain draining to the Sacramento river. Owing to the enormous price of coal, and the number of quartz mines now being operated throughout the mountain region, the smaller water powers have been well developed, while the immense canals with their flumes and pipe lines, originally built for hydraulic placer mining, are being also used by many mines for power purposes. The immense systems of these hydraulic works is appreciated when one considers that the total amount of money invested is over $100,000,000, and that in one county there are 489 miles of canals built at a cost of $3,000,000. Mines using water power from this source pay 18 cents per inch for 24 hours, which makes the cost per h. p. according to the head obtained—300 to 600 ft.—from 11 to 25 cents per day. The only paying mine depending on steam power gives the cost of a h. p. per day at 46 cents; so, notwithstanding the high price charged for water, there is a saving over steam of from $25 to $50 per day. The plant of the San Antonio Electric Light and Power Company transmits power 15 miles to Pomona and 30 miles to San Bernardino, being at present the longest power-transmission line in this country. The power is obtained from a cañon creek, which has a minimum discharge of 21½ cu. ft. per second, supplying four wheels developing 800 h. p. under 400 ft. head. Another important plant is one now being constructed by the Folsom Water Company to transmit electric currents 18 miles to Sacramento. A dam of splendid proportions, 650 ft. long and 89 ft. high, containing 48,500 cu. yards of solid masonry, turns the American river at a point 210 ft. above sea level into a canal 50 ft. wide and 8 ft. deep, constructed for furnishing power to the State prison, and for irrigation. The fall at the prison is 7.3 ft.; the wheels used are 37 in. in diameter, giving a maximum of 1300 h. p. The fall is over 80 ft. at the Folsom end of the canal, where four pairs of horizontal wheels are to be placed, making 4800 available h. p., of which 3000 will be transmitted to Sacramento. A company has been incorporated to furnish San Francisco with electric currents, generated at Clear Lake about 75 miles from the city. San Francisco has 300,000 inhabitants, and manufacturing establishments which consume about 60,000 h. p. at a cost of $7,200,000 per annum. The cost of a hydraulic and electrical plant to deliver 20,000 h. p. to the city is estimated at $4,000,000.

MUNICIPAL OWNERSHIP OF PUBLIC CORPORATIONS.

By M. J. Francisco.

UNDER our present systems of government the number of public officials is limited. In order to increase the list and enlarge the field for political corruption and power, a movement has been inaugurated demanding that governments (State, national, and municipal) shall own and conduct all large commercial enterprises. If this plan could be carried out, the political offices to be filled would be multiplied a hundred thousand times. Then the great army of officials necessary to manage the railroads, telegraphs, telephones, express companies, and gas and electric-lighting establishments, with hundreds of other branches of business that the advocates of municipal ownership would bring into the field of politics, would be changed at every election. This would place the country under the control of a vast army of office-holders, whose only aim and object in life would be to retain their grasp upon office, regardless of the welfare or best interest of the municipality or nation. We are told that by this plan we should secure better results with less expense. What is the record of government, State, and municipal ownership during the century that is closing?

In 1815 the net revenue of the English post office was about $8,000,000, and continued at this rate for 20 years. The people at this time were opposing this government monopoly and the tax to sustain it, as it appeared that the charge of 14 cents on each letter resulted in an expense for postage to some London houses amounting to $50,000 per year. To avoid this private parties established a "penny post," but the government suppressed it, notwithstanding the number of letters sent by post was only as one to ten sent by private means. This shows conclusively that the object of the English post was revenue and State surveillance, rather than a means of benefiting the masses.

The United States post office department is often cited as an illustration of the success of government ownership. Where would the benefits of the post office be, were it not for the aid of private corporations who transport and deliver the mails,—the most important part of the whole process? This is not done by the government, but by private capital representing millions of money. The power of the post office department has been used as a vast political machine for

rewarding friends, and the *Boston Transcript* states that "the month preceding the presidential election the greatest percentage of removals was made of any month for four years; whole lines were stripped of their experienced men, and the creatures of politicians were put in their places."

We will not consider the abuse of which the telegraph is capable for political purposes when in the hands of the party in power. It is conceded by all who have made it a study that private management renders better service, with lower rates and more accurate delivery, than can be obtained under government control.

A member of the New York Associated Press, one of the largest patrons of telegraph companies in the world, says that "the average time of transmission on the Western Union Company's lines is shorter than on any European system, and the number of errors made by American operators is much smaller than by European operators." Errors in this country average only about the fiftieth part of one per cent., but in Europe they are so common that the *London Times* said "the government telegraph was a failure," and that "it can hardly be doubted that, if the telegraphic wires of the country were in the hands of private companies and were administered by private enterprise, instead of being a government monopoly, the public would gain largely in rapidity, cheapness, and extension of telegraphic communication."

Experience shows that in Europe and America State aid to railroads has resulted in immense losses. Most of the State railways in Austria, after an unsuccessful trial, were sold to private corporations for about half of their real cost. Mr. Kapp, in a letter published in *The Nation*, referring to government ownership in Germany, says: "Henceforth it will be advisable for a railroad employee not to vote otherwise than in accordance with the political opinions of his chief. Railroad officers, post-office and telegraph clerks, no longer dare to petition in their own names to the Reichstag, because they are threatened with punishment if they do so." In Italy the government took the system into its own hands, but, the gross receipts being continually less than the expenses, a special commission was appointed to investigate, and, after the most thorough and careful investigation ever made, it reported that "State railroads did not as a rule do so much for industry as private railroads; that, in general, their rates were higher, their facilities worse, their responsibility less, while the State railroad management was more apt to tax business than to foster it: political considerations were brought into matters of railroad construction and management in a way which was disastrous alike to railroads and politics."

The plan of investing State funds in commercial adventures has been repeatedly tried in this country, and in every case has proved disastrous. Massachusetts invested $18,000,000 in railroads, and saved only $6,000,000. According to the State treasurer's report, nearly one-half of the State debt of Massachusetts was caused by the State's connection with railroads.

The investment necessary to enable the government to own all the railroads, telegraphs, telephones, and gas and electric-lighting companies in the United States would amount to over $50,000,000,000 and require an army of over ten million employees. It is easy to foresee the effect upon business that would result from a change in this army at every election.

No one can deny the disastrous result upon any service of placing incompetent political tools in charge of it and frequently replacing them by others equally unfit. The history of this country under "the spoils system," with the wild scramble for office after every election, is positive proof that this plan would be carried out in all branches of service. The men who had become accustomed to the business would be turned out, and new politicians and bosses, utterly unacquainted with the work, would be appointed to take their places until another change, and so on, *ad infinitum*.

All the railways in the United States may not have been successful, but it is a fact beyond dispute that under private management the freight rates have steadily fallen in the interests of the people, and that this country commands the cheapest rates of any nation in the world.

The same conditions exist under municipal ownership that are found under government or State ownership, but on a smaller scale. Judge Dillon says: "Our large cities are encountering the perils of corruption and fraud on a gigantic scale engendered by the large revenues and official patronage at their disposal, and the disinclination—often the steady refusal—of the substantial citizens to take a controlling part in the management of municipal affairs."

The public debt of the city of New York represents a vast aggregate of moneys wasted, embezzled, or misapplied, and the disclosures before the Lexow committee ought to be sufficient to prevent for all time any enlargement or extension of municipal patronage and corruption. Philadelphia's corrupt management of its gas works, which involved the tax-payers in a loss of $3,500,000 in six years, is another illustration.

No wonder Judge Dillon said: "The legislature should be prohibited from allowing municipal corporations to engage in extra-municipal projects, or to incur debts or levy taxes for such purposes."

Committees, unacquainted with the business and with no practical

experience in electrical affairs, are appointed by city councils to investigate and ascertain the cost of producing light in cities owning plants. This is done with a view of purchasing a plant. The worthlessness of such information and the unreliability of such investigations have been demonstrated times without number. They go to the officials of other cities, who have no knowledge of the science of electricity or its practical application, and whose information regarding the working of their own city's plant has been obtained from employees who owe their appointment to the influence of some political wire-puller whose interest it is to show a minimum of expense. Statements of this kind are used as authority regarding the cost of municipal lighting, notwithstanding the fact that they are discredited by men who have made it a study for years, have thoroughly tested every branch of the business, and are not beholden to a political boss for their position.

A party having a suit in the United States supreme court would not employ a carpenter to take charge of the case; neither would he go to a hod-carrier for information regarding the running of the "Empire State Express"; but it is precisely by such a policy that advocates of municipal ownership govern their action. The representative of some manufacturer interviews the mayor or aldermen, furnishing a glowing account of a system by which electric lights can be produced for a mere trifle (provided they adopt his plan); then he refers them to other cities where the mayor and aldermen have been worked in the same way, knowing nothing whatever about the business or its practical application, having adopted it through the influence of some other party working either for pay or a "political pull." A few politicians are hired to boom the plan, and make speeches favoring it at the public meetings that are to be called. Garbled statements as to cost in other places, giving about half the expense, are provided. In this way the tax-payers are hoodwinked into voting for its adoption, and the sale is completed. The agent then starts for another city to repeat the same operation, and refers the aldermen in this new field to the last place which he has worked, informing them that, after a long and thorough investigation, his plans were adopted.

The fact that one city pays double the amount for the same grade and make of apparatus paid by another indicates that the cost of aldermanic influence was greater in the former than the latter city; but the tax-payer furnishes the money to pay for the plant, as well as all money spent in buying aldermen's votes.

The tax-payers in many places where municipal plants are found (furnishing lights to private parties at a price less than the actual cost of producing them) do not seem to realize that they make up this ex-

pense and loss to the city, in order to benefit a few citizens who use these private lights. A large proportion of the people in a city who do not use electric lights are taxed in this way for the benefit of a few who desire this luxury in their residences or places of business.

The *New York Sun*, in an editorial upon the subject, says: "Why may it [the State] not proceed to take and run the railroads and express companies, to work the mines, and then go on to the management of all manufactures, and finally to the control and monopoly of all business, to the entire destruction of private enterprise? Then everybody who worked would be in the government employ, prices would be regulated by government, individual enterprise would be gone, and with it would go the liberty for which mankind has ceaselessly struggled through so many centuries. The Roman empire made about the same experiment in the fourth century, with the consequence that, not only the empire, but also society itself went utterly to pieces."

The experience of the most sagacious men in the nation shows that municipal ownership is not conducive to the best interest of any city. Professor Ashley of Harvard University, who was at Toronto at the time the changes were made in municipal management there, says: "I am thoroughly in favor of private management. I came to this opinion after four years' experience of Toronto city government, starting originally with a very strong leaning toward municipal management."

It is only necessary to give the experience of cities which have tried the experiment to show the worthlessness of the claim that municipalities can produce light at less expense than private corporations. As an illustration of this, I will refer to Wheeling, West Virginia, which recently installed a plant of four hundred arc lights to burn all night, using steam power, coal costing $1.00 per ton. Before this municipal plant was established, the local company offered to furnish any number of lights that might be desired, to burn every night and all night, for $72.52 per lamp per year. Parties in Wheeling who had political aspirations made the claim that a plant could be installed for $26,000. This was afterwards raised to $40,000 and again to $60,000, while the actual cost proved to be $125,000. The advocates of municipal ownership represented to the tax-payers that the total cost of running four hundred arc lights, if the city owned the plant, would not exceed $14,000 per year, being $35 per lamp. They adopted the plan, and bonded for $80,000 at 6 per cent. interest, besides using $22,233 of the gas-works' funds (owned by the city) in installing the plant. The principal was payable at the rate of $8,000 per year. Six dynamos were installed with five circuits, one dynamo

to be kept as a spare machine. Soon after starting, the armatures began to burn out; lamps were taken off in the hope of relieving the dynamos, thereby stopping the heavy loss; but this did not answer the purpose. In 1894 it became necessary to buy another dynamo and cut down the number of lamps on each circuit, making six instead of five. The city clerk, on page 4, reports the cost of maintaining lights one year at $30,142.42. This does not include interest, depreciation, taxes, insurance, or water rent. During 1893 the funds of the gas trustees were exhausted; a coal bill amounting to $15,659.15 could not be paid, as the city authorities had been allowed to use $22,233 of the funds in constructing the electric-light plant. In view of the city's heavy indebtedness, and the fact that its finances were so low that it could not pay the interest or the $8,000 of principal on bonds which were due, the bondholders agreed to extend the payment of interest and bonds another year. The fallacy of the claim made by the advocates of municipal ownership that the entire cost of running the plant for a year would not exceed $14,000 is shown by the actual experience for a year, during which time the pay-roll alone amounted to $17,191. The tax-payers have learned the truth regarding municipal ownership, and there is trouble; the constant refrain now heard is the "electric elephant on their hands." This is one illustration of the results produced by adopting the unreliable reports and figures used by the advocates of municipal ownership. Experience is a very good teacher, but sometimes rather expensive; and, when the authorities found that it was costing them $112.73 per lamp per year for the same light that the local company offered to furnish for $72.52, they no doubt would have cheerfully dumped the parties whose advice they had followed into one of their huge political machines to see if it would increase the number of amperes required and decrease the steady loss.

Statements have been scattered broadcast by the advocates of municipal ownership that the entire cost of light at Little Rock was only $51 per lamp per year. Many cities and committees have based their calculations upon this statement, and voted to adopt municipal ownership because the expense, as shown by reports from Little Rock, was so much less. Upon investigation, it appeared that two reports were made by the authorities of Little Rock, one of which gave a glowing account of the electrical business. The other seems to have been made for the information of the aldermen only. On page 17 of this second report, the city clerk says: "In compliance with your request, I have made a comparative statement of the expenses of this department. The statement made by the city clerk in January must be corrected, notwithstanding the report has gone out that this city has been run-

ning its lights for $51 per lamp per year. The expenses for this year are $8,043 84, which equals $80.43 per lamp per year." This report was made to the mayor, and shows that the cost of lights until midnight, on moonlight schedule, not including interest, depreciation, insurance, taxes, or water rent, was $80.43 per lamp per year. The city clerk also plainly states that the previous report, which had been scattered broadcast, was false. The Kansas City committee were informed that the total cost of lights was $47.45 per lamp per year, and the Hamilton committee were given $69.83 as cost, while the Evansville committee were told that the cost was $70; and the superintendent states, in his report to the mayor for the same year, that the cost was $80.43 per light. The statement that was sent the committee of Kansas City, showing that lights only cost $47.45, has been produced by the advocates of municipal ownership before almost every city council that has called for the cost of lights at Little Rock. The mayor, in his message (page 5 of city report), says: "The electric plant is composed of old antiquated machinery." This statement was made by the mayor only three years after the plant was installed, and thereupon an appropriation of $30,000 was made for repairs and new apparatus, although, as the report shows (page 18), $9,622.70 had already been spent for repairs. Here we have the record of a municipal plant after three years' use, and, if we add the expense of repairs to the $80.43 which the superintendent says the lights cost, we have a fair illustration of the benefits to be derived by a city attempting to manage a commercial industry.

Judge Cooley well says: "In a large number of cases the anticipated benefit was never received, and, as is likely to be the case where municipal governments take part in projects foreign to the purpose of their creation, it has furnished unusual facilities for fraud and public plunder, and led almost inevitably at last to discontent."

The facts cited above show the practical working of municipal plants. The same analysis could be made of nearly every one in existence, if space permitted, with the same general result.

The political record of this country shows conclusively that the constant changes caused by alternating party triumphs must destroy all interest in governmental enterprises on the part of those in charge of them, who well know that they hold their places only during the term that must elapse between elections. The politician who wins will reward his friends by placing them in charge, regardless of the fact that they have had no experience in the business. In this way the mechanical and other details that must be carefully watched and guarded in order to make the enterprise a success are neglected, and the tax-payers wonder why the mysterious power called electricity eats up so much of

the public money. The council of the city of Philadelphia made a very extensive investigation of the subject of municipal ownership, calling upon the best-posted men in the country for their experience, and also securing the testimony of experts, which filled over one hundred and forty printed pages. Specifications of the cost of installing a plant were demanded. The director of public safety employed an expert to make specifications, and it was estimated by him that the total cost would be $97,360. The chief of the electrical bureau made specifications, which placed the probable cost at $100,510. Mr. Cowling made specifications, showing a cost of $221,907.50. The committee made specifications, showing a cost of $251,763. Here we have the estimates made by four different parties, all based upon the same number of boilers, engines, and dynamos,—in fact, every one was for precisely the same capacity of plant,—and the difference between the estimate made by the council committee (some of whose members were practical electric-light men) and the estimates made by the city director and his expert, who were in favor of municipal ownership, was $154,403. After this, the most thorough and most complete investigation of the cost of electric lighting ever made in this country, the council voted against municipal ownership.

This shows plainly that, when an honest investigation is made, it will convince any board of aldermen who are acting for the best interest of their city and its tax-payers that it is their duty to oppose municipal ownership.

A college professor without practical experience or knowledge of the business published a text-book for use in schools, in which, on page 302, he made the statement that the cost of electric lighting, when a city owned the plant, was 33⅓ per-cent. less than when lights were furnished by a private corporation. As an illustration, he cites the city of Rutland, Vt., stating that the private company compelled the city to pay $280 per lamp per year, and upon this basis he shows a saving of 33⅓ per cent. in favor of municipal ownership.

What are the facts in *this* case? The city referred to, in which, according to the professor's statement, the lights cost $280 per lamp per year, has paid during the past five years an average of only $89.40 per lamp per year, burned every night until midnight, and this, too, with the poorest quality of soft coal, costing $4.50 per ton.

As the writer has checked every lighting bill paid by the city during the above time, he knows whereof he speaks. Still, the statement made in this text-book, in which the cost of lights per lamp per year is placed at a figure exceeding by $190.60 the price actually paid, has been copied and sent broadcast as an illustration of the benefits of municipal ownership and an argument for its adoption.

The time for municipalities to own and conduct commercial industries has not arrived, and will not arrive until men are born into a world where politicians and aldermen protect tax-payers and refuse "boodle"; when children are removed from parental influence and nurtured by the State, as advocated by Plato; when employees, with no interest in the business except to aid the political bosses and draw their salaries, can conduct the business more economically and successfully than men who have perhaps every dollar of their fortune depending upon its success; when, in fact, the millennium arrives, and the whole human family is transferred to some eternal city lying beyond the misty shore of time. Until that time comes, let all cities confine their business to regulating and governing, leaving commercial industries with their hazards and losses to individuals and private corporations.

THE CONTROL OF PUBLIC-SERVICE CORPORATIONS.

By Allen Ripley Foote.

"Let all cities confine their business to regulating and governing, leaving commercial industries with their hazards and losses to individuals and private corporations."
M. J Francisco.

I AM asked to prescribe a remedy for existing evils growing out of the relations between municipalities, municipal public service corporations, and the users of the services rendered by them. A true settlement must be one that will correctly balance the interests of all these factors, and give to each the advantages it can justly claim.

The first principle to be recognized is that the greater interest must always control the lesser. Upon this principle government by the majority is founded. A public improvement, such as widening a street in a congested portion of a city, may cause many individuals much inconvenience and loss, for which no compensation is provided; but, being a direct advantage to a much larger number of persons and of great general advantage to the municipality as a whole, the few must acquiesce to the convenience of the many, and permit the work of widening the street to be done.

There is but one limit on the rule of the majority. That is, its action must be just. This limitation circumscribes every person, and every group of persons from the smallest combinations to the greatest nations. To establish justice governments are organized. When justice is established, a correct balance will be firmly maintained between the interests of the municipality, of the corporations, and of the users of services, so that the relations between them shall be those of mutual benefit and helpfulness. In the domain of justice it is impossible that any person or group of persons can be permanently benefited by their own acts of injustice. If this were not true, there could be no justice.

It is not good business to secure a temporary advantage at the expense of a permanent advantage. That which is for the moment an advantage may, in the larger view, be seen to be a loss. A burglar may have a temporary enjoyment from his ill-gotten gains, but it is impossible that he should permanently improve his life in such a way. Attempts to secure more, or to give less, than justice requires are the cause of all the injustice from which mankind suffers. What municipal public-service corporations shall give for what they receive; what the users of the services rendered by them shall receive for what they pay; how collective municipal interests shall be benefited by the col-

lective demand guaranteed to corporations through granting them special privileges,—are all questions that cannot be correctly settled, and from the settlement of which no permanent gain can be made, unless they are settled in strict accord with the requirements of ethical and economic justice. A gain of high value will be made when this fact is clear to the perception of every one.

Coming now to practical considerations, it must be apparent to every one that all factors of uncertainty increase the cost of doing business; therefore all acts of commission or omission which result in uncertainty as to the perpetuity or the exclusiveness of the business of a public-service corporation must increase its price for the services it renders. The increase of a price for such a reason is an unjust tax on the users of the service, because it is unnecessary. A striking illustration of the cost of uncertainty is furnished by the sale of sixty-two millions of United States *coin* bonds to draw 3¾ per cent. interest, when the buyers offered to accept *gold* bonds at 3 per cent. interest. Had congress ordered $16,000,000 of gold taken from the treasury and sunk in the ocean beyond the power of recovery, the economic result for the people would have been the same as now; but the indignation of the people would be overwhelmining, because the directness of the plunder and wanton waste would enable them to understand the injustice of the act. As it has been done, the indirectness of the effect and the slowness of its manifestation permit the people to sleep while the blood is quietly sucked out of their economic system.

In the organization and control of municipal public-service corporations the chief factors of uncertainty that can be at once eliminated by the repeal of unjust and the enactment of just laws are those regulations limiting the duration of the corporation, limiting the time for which it may make a special use of the highways or privileges where its plant is located, and then adding a guarantee that it shall not be encroached upon by any competing organization. In every department of endeavor the expectation of securing a future good is the energizing power relied upon to stimulate right doing. Justice requires that faithful and efficient service shall be the royal title to the right to perform the service as long as it may be required. Such an assurance is the only condition that will justify a workman in yielding up his life in preparation for and in doing perfect work in any vocation. Such a condition is the only one that will justify public-service corporations in providing the best constructions and equipments known to their art,—which are safer, more reliable, and less expensive to maintain than those built for a comparatively temporary use. The regulations should require a corporation organized to supply a special need to construct works designed to supply the need as long as it exists.

The chief objection to granting exclusive franchises is found in the belief that competition is necessary to force low prices. But in the domain of governmental economics we have an effective substitute for competition in the right to control charges by means of wisely-devised systems of arbitration. In determining the price a corporation should charge for its services, justice requires an examination of all evidence offered and will permit the cross-examination of every person giving evidence. Its findings will be based upon the ascertained necessary cost of producing the service, plus a fair return for the interest and profit of the capital employed. Such a method will give to a municipality and to the users of the service the full advantage of favorable local conditions of which it may be the fortunate possessor. It will assure the corporation just treatment and relieve it from the expense of lobbying municipal councils or State legislatures in behalf of a fiat price, which it will naturally endeavor to secure at the highest rate possible. Being assured of a continuous right to supply the service, and of just treatment in the price it may charge, the corporation can enter upon the work of furnishing the best known service at the lowest practicable price, with confidence in its immunity from blood-sucking ordinances in city councils or bills in State legislatures. These conditions will relieve it from all unnecessary burdens, such as free service, lobbying expenses, large attorneys' fees, and newspaper protection. Being protected by just laws, it will need no other protection. The fact should be recognized and acted upon that a just price, to be charged by public-service corporations, includes justice for the users of the services as well as for investors in such undertakings; and further, that the determination of a just price is a judicial, not a legislative, function.

The volume of service is an important factor in determining cost. Competition is supposed to stimulate demand through reducing prices. There is a limit, however, to the demand for any service within a specified area. It is not possible for two plants to render a service as cheaply as it can be done by one that could control and supply all the demand within the reach of both. The inevitable result of a multiplication of plants is an increased cost resulting in an increased price, or in a loss on the investment. The first is unjust to the users of the service, the last is unjust to investors in the plants. Uncertainty resulting from short-time contracts, limited life of the corporation, and lack of protection in its area of operation is a far more serious source of evils than a superficial observer can be made to understand.

The city of Baltimore furnishes an object lesson for those who suppose that prices can be permanently reduced by the methods of competition. In unintelligent efforts to secure low-priced gas, fran-

chises have been granted to one competing company after another, until six gas plants, more or less complete, have been built in that city. One after another the competing companies have died, until now there is but one company owning all the works, doing business on an investment several times larger than is necessary.

It has been supposed that it was necessary to leave a margin for speculation in drawing regulations controlling such organizations. This is a mistake. Every element of speculation is one of uncertainty. Every factor of uncertainty retards the investment of capital and enhances the cost of obtaining it. Remove all uncertainty, and capital will clamor for the privilege of an investment in the stocks and bonds of public-service corporations, as it did recently for an opportunity to invest in United States bonds, and at no higher rate of interest. Economically considered investments in the stocks and bonds of productive industries should be as safe as, and more profitable than, investments in political mortgages. The only reasons why they are not so are found in the unintelligent conditions imposed upon, and privileges granted to, them by those who legislate for the people. National banks are organized and inspected under a uniform system. Their managers, investors in their stocks, and their depositors are all vitally interested in keeping them in a sound condition. These three classes include the best business men in every community. If experience has taught the necessity for uniform organization and independent auditing in the case of national banks, is it not fair to assume that important gains can be made for municipalities, municipal public-service corporations, and for the users of the services rendered by them, by a uniform system of organization, accounting, independent inspection, and auditing by State authority?

Such a system would make scientific statistical comparisons possible. It would induce competition, not between corporations in the same city, but between cities to show best results for money expended. The rewards would be growth of cities with a resultant increase in the values of property and volume of business, better service at decreased prices for users, better managed, and more surely profitable corporations.

All the evils complained of exist because there is no well-defined public policy, based on correct economic principles, by which legislators are bound to square their actions and upon which managers of corporations can depend for the protection of their business interests. On account of this deficiency, legislation is in a chaotic condition, and government, instead of being honestly and intelligently directed, is guided by prejudices and guessing. This is the cause of the dissatisfaction and antagonism existing between municipalities, corpora-

tions, and users of services. The self-interest factor in each is not properly adjusted to that of the others. This throws the whole economic mechanism out of order. The result is unnecessary friction, irritation, and loss. A remedy for the evils must deal with the broad question of public policy rather than with specific cases, which are simply local symptoms of a universal disease. The energizing force of self-interest pervades municipal, corporate, and individual action. Properly to settle the problem, the forces of self-interest actuating the factors must be so balanced that at no point will antagonism be developed, but at every point of contact there will be reciprocal benefits and an augmentation of energy. The factor of greatest importance is the self-interest of the users of services. From their patronage is drawn the life-blood of the industry. Upon their prosperity depends the prosperity of the corporation, of the municipality, of the State, and of the nation. The interests of the users of service is satisfied by having service rendered in the best known manner at the lowest practicable price. This desideratum, I maintain, can only be established through properly organized and regulated public-service corporations owning and operating the plants as a profit-producing industry. The requirements for proper organization and regulation are:

Uniformity of organization, accounting, independent inspection, and auditing required by the State. In the absence of any general State laws, then the organic municipal charter should be amended to provide for these conditions.

No issue of stocks or bonds should be permitted except for tangible value necessarily employed in the organization, purchase, construction, equipment, or operation of the plant.

No charge should be permitted for franchises or privileges of any kind.

No limitation should be placed on the life of the corporation, or upon the time during which it may supply the services it is organized to render.

No taxes should be assessed upon the property, business, or income of the corporation.

No competing company should be permitted to divide patronage within the area served by an existing corporation.

Prices charged for services should be adjusted from time to time on the basis of cost of production, plus interest on capitalization, at the rate paid by the municipality on its bonds, and a reasonable profit.

All surplus earnings should be used to retire bonds, without permitting a capitalization of the values represented by them; or, if no bonds, for extending the plant, without capitalizing the investment.

Under these conditions services can be rendered in the best known

manner at the lowest practicable prices, and the corporation stocks and bonds will be the best investments in the world, because the self-interests of the corporations and of the users of the services they render, will be well secured, and the municipality will enjoy the best economic advantages that science and art can devise.

If State and municipal authorities cannot properly regulate and control public-service corporations under these conditions, how will they acquire the ability properly to invest taxpayers' money in the construction and operation of municipally-owned plants or works? Many people honestly suppose that good services at low prices will result from public ownership. This fallacy has gained ground by appeals to prejudice instead of judgment, and very largely by imperfect and misleading statements of the results of municipal ownership. A brief analysis and comparisons of conditions will show that the expectation of making a permanent gain over private corporate management by means of municipal ownership must inevitably be disappointed.

When a government undertakes a business, its function of regulating and controlling that business is obliterated. The power of regulation can be exercised only by an authority outside of and superior to the corporation to be regulated. State regulation of political corporations is vitiated by the intimate relations between municipal and State politics. There is no compensating gain to cover the loss of the power of regulation.

A municipality has no capital except that which it exacts from private property. The process of obtaining capital in this way is expensive. It is unnecessary, if private capital will take the business and conduct it better than a municipality can, at no greater cost to users. Sound public financiering requires that funds shall not be collected by taxation for a purpose that can be served as well by an investment of private capital under private management. If a municipality borrows money for the purpose of constructing municipal public-service works, it must pay interest for its use. Under the conditions I have named private capital will accept the same rate of interest. No gain can be made on this item.

The difference between the cost of public work, even when erected by contract, and the cost of similar work when done for private account is proverbial. No city is without an illustration. The reason for this is easily found. In the case of public construction, public funds are expended by those who have no interest in the investment, and the investment is made without any idea that the plant constructed must earn a commercial profit as a condition governing its continual operation or the employment of the managers and employees engaged in its operation. The self-interest of those engaged in the

work of construction is detached from the work in which they are engaged, causing an inevitable indifference to its best economic execution. No gain can be made in cost of construction.

A municipality permits no competition, pays no incorporation or other taxes of any kind, pays nothing for franchises, and has no limit on its corporate existence, or upon the time during which it shall render the services which it undertakes. It is an untaxed, perpetual, exclusive, and uncontrolled political monopoly. To make comparisons equitable, these conditions must be granted to private corporations, except that of no control. The loss of proper control occurs when municipalities engage in business. What reason is there to suppose that a municipal government would manage the street-car service well, when it cannot well manage the simpler work of street-cleaning? If it is less efficient in management, then its management must result in a loss; and this is the result of every case of municipally-owned and -operated plants for rendering industrial public services, all pretended records to the contrary notwithstanding. The attempt to secure a gain by divorcing the self-interest of the worker from the work he is to do is contrary to the instincts and reason of human nature. It is not in accord with ethical or economic law. It cannot be done.

The paramount consideration to the people of every municipality *is the right to control.* If the control be wisely and justly administered, no sort of ownership, participation in profits, or franchise price can possibly equal the public benefits which are certain to accrue from judicial control.

REDUCING THE COST OF ELECTRIC LIGHT.

By Nelson W. Perry.

IT is so easy to prove on paper by means of apparently legitimate assumptions that the electric light can be made to sell at a considerable profit at a figure which is but a fraction of that usually charged that the public has been easily convinced that a bonanza attended the procurement of an electric-lighting franchise in almost any municipality. The rude awakening to the investor when the annual statement has shown a balance on the wrong side of the ledger, in the face of the brilliant promises held out by lead-pencil prophecies, has too often come as a shock for which there seemed no other explanation so ready as that of wilful misrepresentation and dishonesty. The electric-lighting industry has, therefore, suffered in reputation to such an extent as to make it difficult at the present day to float enterprises even of the most legitimate character. That dishonesty or incompetency has too often been charged where it did not really exist can readily be proved by figures from actual practice which show shortcomings in the performance of machinery that even central-station managers are only now beginning to realize.

A year ago the committee on data of the National Electric Light Association reported data of coal consumption per indicated h. p. in a large number of central stations which attracted wide attention at the time, as indicating poor engineering practice. It was stated that, with a consumption of 1.5 lbs. of coal per indicated horse-power, with a combined engine and dynamo efficiency of 81 per cent., a production of 402.84 watt-hours per lb. of coal would result. This was equivalent to .54 electrical h. p. per lb. of coal, or, in other words, an electrical h. p. could be generated for 1 hour on a consumption of a trifle over 1.8 lbs. of coal. The assumptions on which this statement was based seem entirely legitimate, since engines of a guaranteed efficiency of 90 per cent., and dynamos of an efficiency of 95 per cent. are readily obtained in the market, and it is not unusual to find a combined efficiency, under test conditions, of 85 per cent. These being facts, it was with considerable surprise to many that the results of actual practice were announced. The highest results given were 208 watt-hours per lb. of coal. The next highest was 192, the lowest 25, and the average 91.7 watt-hours, or only 22.7 per cent. of that which was attainable by the best practice. In other words, the average central-station practice required 8 lbs. of coal to produce the

same amount of electrical energy that machinery readily attainable was capable of producing on a consumption of 1.8 lbs.

This was a showing so unfavorable to electrical engineering practice as to cause considerable comment in the electrical journals and lead to some question as to the correctness of the figures. An average of data picked up hap-hazard, however, is not to be taken as a fair average of practice, and, since lower averages in efficiencies are to be expected in small stations where the units employed are small than in larger ones where apparatus of the highest refinements and possibilities are the rule, I discarded the reports from all stations consuming less than 10,000 lbs. of coal per 24 hours, and, averaging those above this, found a result of 127.7 watt-hours per lb. of coal, or a consumption of about 5 lbs. of coal per electrical horse-power hour. This was a result which, in ordinary steam practice, would be poor even with small non-condensing engines, and yet undoubtedly most of the engines employed in the works whose results were considered were large compound engines, double or triple expansion and condensing.

At first blush these figures would seem to imply something radically wrong, and it was but natural to turn to foreign practice to see how it compared with ours. Such a reference shows that in the best English central stations the discrepancy between what ought to be and what is is even greater than in this country. Prof. Unwin is authority for the statement that probably the consumption (in England) has in no case been less than 3.3 lbs. of coal, per indicated h. p. This, with the assumed efficiency of 81 per cent. for engine and dynamo, would be equivalent to 4 lbs. of coal per electrical h. p., and reports from several of the large London stations show a consumption of from 6 to 8 or more pounds.

It was some satisfaction to find that American practice was at least no worse than that of our cousins across the water, who pride themselves upon greater refinements in engineering detail than we possess.

This same committee on data had been continued, and during the past year had been engaged in collecting further facts in regard to central-station economy, and their report, which was made at the Cleveland Convention last February, was awaited with considerable interest.

This report embraced data from twenty-four central stations, among which were several of the largest in the country,—seventeen of which exceeded 10,000 lbs. of coal consumption per day. The average consumption of coal for all of those reporting was 127.7 watts per lb. of coal, or 5.8 lbs. of coal per electrical horse-power hour. Taking as before only those stations consuming more than 10,000 lbs. of coal per day, we find the average to be 5.79 lbs. per electrical horse-

power hour, which is a better showing for the average of all reporting, but not so good a showing for the average of those stations consuming in excess of 10,000 lbs. of coal per day. A very marked advance was shown, however, in this report in a single instance, which reported a total daily output of nearly 23,000,000 watts per day on a consumption of 87,358 lbs. of coal, which is equivalent to a consumption of a little more than 2.84 lbs. per electrical horse-power hour. This particular station, however, was the only one doing better than 4.1 lbs. of coal per electrical horse-power hour, whereas in one case the consumption was as high as 24.8 lbs., and there were six reporting more than 7 lbs.

These figures are startling, and at once suggest the inquiry as to the cause of these low results. The answer cannot be more completely given than by quoting from some tests made by Prof. Kennedy at the Millbank Street Station of the Westminster Electric Supply Corporation. Dividing the day into three portions, he determined the fuel consumption and the electrical horse-power developed during each period as follows:

TABLE OF COAL CONSUMPTION IN BOILERS WITH VARIABLE LOAD.

	11 A.M to 6 P.M. 7 hrs.	6 P.M. to Midnight 6 hrs.	Midnight to 11 A.M. 11 hrs.
Total I. h.p. hours	562	1366	407
Total E. h.p. hours	400	979	260
Coal per I. h.p. hr. lbs.	6.88	3.26	6.26
Coal per El. h.p. hr. lbs.	9.67	4.55	9.80

This table shows very clearly the effect of light load upon coal consumption on engines of the same class, and, although the best figures given—4.55 lbs. of coal per electrical horse-power hour, while the machinery was operating at its largest load—leave much to be desired, it is shown that even these are doubled during the hours of light load. They show unmistakably that at least one prolific cause of lack of economy in central-station practice is the extremely variable load to which the central lighting station must cater, and, when we consider that even in New York city at least two and a half times as much machinery must be installed as could, if working continuously, produce the same gross output, we see another cause of expense in the way of interest and depreciation charges, which, in the lead-pencil estimates, are apt not to be considered, or at least to be insufficiently provided for.

In fact, that these increased costs due to variable load are not well understood even by those presumed to be fairly well posted was well illustrated by some editorial comments in one of our leading engineer-

ing magazines upon some figures given by the author, which assumed the coal consumption per electrical horse-power hour under the conditions of continuous operation at 2.21 lbs., and that under ordinary conditions of practice at 4 lbs., the disparity being characterized as absurd. It seemed to me, therefore, probably not uninteresting to lay the facts before the public, who may not be expected to be so well posted as editors in general are supposed to be.

But, while the item of fuel is an important one in the cost of electrical energy, it is by no means the only one which is seriously affected by the variable character of the central station. I have already referred to its effect upon interest and depreciation charges, and these may in some cases become more important than the fuel charges. It is these that so often render the employment of water powers uneconomical, and which must militate so largely against the economical results from the great Niagara electrical-power scheme. The most noteworthy electrical-power transmission scheme that has thus far been tried was that of the Lauffen experiment in 1891, in which some 300 horse-power were transmitted electrically from the falls of the Neckar at Lauffen to the Frankfort Electrical Exposition grounds,—a distance of 108 miles. Technically this was a great triumph, the efficiency of transmission having been about 75 per cent. Commercially, however, it was a failure, since the power cost, when delivered, five times as much as it could be produced for locally by means of steam. Thus we see how enticing water-power projects often fail commercially, independently of fuel charges or apparatus efficiency, but through exorbitant fixed charges incurred in rendering available what would otherwise prove a cheap source of energy.

There is also a popular misconception as to the relative costs in distribution of energy by different methods. Probably nine out of every ten to whom the question was propounded would answer unhesitatingly that energy for lighting purposes could be delivered more cheaply at a distance by electrical means than by means of gas-transmission, and under some conditions this is true; but I find by calculation that, if the distance involved were a mile, it would require considerably more metal to supply the electric lights by means of the direct current than would be required for pipes to convey a supply of gas for the same number of lights with the same efficiency of transmission.

The bane to the electric-lighting industry is, therefore, the peculiar service which it is required to supply, reaching a very high maximum for a very few hours, and then descending to a very low mean, during which time the apparatus has but small earning capacity, and that portion which is not lying totally idle is producing energy at an uneconomical rate.

Could the central-station apparatus be kept in operation continuously at its most efficient output, the electric light could be sold to consumers at a considerable discount upon the price of gas, and still net the manufacturer a larger profit than the gas-man realizes, and this without any change in apparatus or methods of distribution from those now in vogue.

The gas manufacturer, though he have exactly the same service to meet as the central-station manager, is not handicapped by the irregularity of this service, in that he can store up the product which he has to sell, when the product is greater than the demand, and draw upon this store during the hours when the demand exceeds the supply. He need only supply sufficient apparatus to meet the average demand, and this, being kept in continual operation at its most efficient rate, earns to its fullest extent for every hour in the day. The central-station manager, on the other hand, has no method of storing up the product which he has to sell. If he employ storage of any kind at any stage of the manufacture, it introduces additional transformations of energy which not only are apt to be expensive in themselves, but also involve necessary losses in final output which must be balanced against any economies which they may present.

It is natural, therefore, that relief should be sought rather in increasing the regularity of the demand than in these methods of storage; but here, too, difficulties present themselves which have not as yet been obviated. In the first place, if a day-load should be acquired, it would tend to overlap the maximum lighting load which in winter time comes on before six o'clock, and on dark days may be an hour or two earlier. The result would be that the double load which at most would last but two hours, and which in the summer time would not exist at all, would have to be provided for by machinery which would be idle the rest of the day. It is clear, therefore, that this change would not better matters much.

What promises to be a better method is one that has been tried on a small scale abroad, but not yet, to any extent, in this country,—*viz.*: encouraging the use of current during the hours of light load by reducing the price of service during those hours. The central-station manager could well afford to reduce his price to a mere fraction of what he now charges, if by that means he could obtain a steady demand for his product throughout the 24 hours.

Mr. H. Ward Leonard, who has given this subject more study perhaps than anyone else in this country, said in a paper recently read before the American Institute of Electrical Engineers: "If central-station companies would offer such a discount due to load factor as to warrant their individual customers in installing at their own ex-

pense a storage plant which they could charge at the minimum rate per kilowatt-hour, and then use this stored energy to supply their occasional demands, I believe it is possible that the central-station companies, the storage-battery companies, and the consumers might all derive a profit from the arrangement. I have no doubt that a central-station company could afford to make a rate of four cents per kilowatt-hour for a continuous service night and day, and make a satisfactory profit, while it would surely lose money in supplying an elevator at fifteen cents per kilowatt hour." If electrical energy were supplied to a customer at the lower figure, it would mean electric light at about $\frac{1}{6}$ cent an hour instead of 1 cent as now charged, or $\frac{3}{4}$ cent for gaslight, where gas costs $1.50 per thousand cu. ft.

In this connection he gives the following schedule of rates, which he thinks should be charged per kilowatt-hour to customers, according to the proportion of the 24 hours they use current, together with the resultant gross income that these charges would bring into the central station:

Load Factor.	Rate per kw. hour in cents.	Resultant gross income per annum per kw. of plant.
5	30	$131.40
10	20	175.20
15	16	210.24
20	13	227.76
25	11.2	245.28
30	10	262.80
35	9.2	281.07
40	8.5	297.84
50	7	306.60
60	6	315.36
70	5.3	325.00
80	4.8	336.38
90	4.4	346.89
100	4	350.40

It will be noticed that, although, when the customer uses current but 5 per cent. of the time (which is better than the average of electric-light consumers), he is charged seven and a half times as much per kilowatt-hour as when using it continuously, the gross income to the central station is only about one-third what it is from the lower figure. Or, in other words, the central-station company would, according to these figures, get a gross return nearly three times as great by selling its current to a customer who would take it constantly at a rate of $\frac{1}{6}$ cent per lamp per hour than it would get from the customer who used his light but 1½ hours per day, and who paid it at the rate of 1¼ cents per lamp per hour.

Doubtless some such arrangement as here suggested will in time be resorted to in this country to the advantage both of the consumer and the manufacturer.

Then there is another method by which relief may be obtained,—*viz.*, by finding some by-product for the central station man to manufacture during the hours of light load. I use the term "by-product" advisedly, for it must be something whose manufacture may be stopped the moment the machinery is required for the main business. The manufacture of ice is one such "by-product" that has found some favor among central-station men; but, while this may give employment to boilers and engines during the day-time in summer, the dynamos are lying idle even during the few months when there is a demand for ice, and during the winter months such a plan would afford no relief whatever. It would be far preferable if some electrical product could be found, for this would give employment to all of the machinery at all times of the year when not otherwise required. This, in fact, is the invention which is most required at the present day, and seems more possible of attainment than any other form of relief thus far suggested.

One of the recent products of the electrical furnace that looks promising for this purpose is calcium carbid,—a product not new to chemistry, but new to commerce. This substance, which is produced by the fusion of lime and coal-dust in the electric arc, when decomposed by the simple addition of water, gives rise to acetylene gas,—one of the most highly luminous gases known, as well as possessing the highest calorific powers of any of the hydro-carbon gases. We, on this side of the Atlantic, have been rather skeptical as to the advisability or practicability of undertaking the manufacture of calcium carbid, but the proposition has been given a standing which at least makes it worthy of consideration by our continental friends, who are about to undertake it. It seems that a company has actually been formed in Germany for this purpose, known as the "Gesellschaft zur Verwerthung von Acetylen-gas." That this is no mere hap-hazard, ill-digested concern is evidenced by the fact that the great German electrical concern of Siemens & Halske has taken a substantial interest in the project. Should the undertaking prove a commercial one, it will be of the utmost import to the central-station man, and the outcome will be awaited with the greatest interest.

The commercial status of the manufacture remains, however, to be proved. There are two other products, however,—already objects of commercial manufacture,—whose status is already determined. One of these is aluminum, and the other carborundum. These articles are already being manufactured on a large scale, and their manufacturers

are seeking cheaper power at Niagara to enable them to increase their outputs at lower figures. The question arises: would it not pay the central-station man to manufacture these products during the hours of light load, at a figure with which even the cheap water-powers at Niagara could not compete, if by this means he could keep all his apparatus occupied at its best rate throughout the twenty-four hours, and thereby reduce the cost of his electric light by from 50 to 75 per cent?

As indicating the cost of power in ordinary practice when it is produced in a fairly continuous manner, I may cite the case of the Chelsea Jute Mills of Brooklyn, which, during a period of six days, while developing an average of 653.3 indicated h. p., consumed but 1.482 lbs. of coal per indicated h. p. per hour. This is equivalent, if we assume a combined engine and dynamo efficiency of 81 per cent., to a consumption of 1.83 lbs. per electrical h. p. hour.

During this time the load was by no means constant, but varied between 495.21 and 764.96 h. p. The equipment consisted of Corliss compound condensing engines and vertical tubular boilers, and was in operation 10 hours each day. The figures given cover the whole amount of fuel used, including banking, etc. Most of our modern electric-lighting stations have quite as good an equipment as this, and yet statistics show that the best of them average 7 to 8 lbs. of coal.

The demand of the day therefore is *not* better dynamos, better engines, better boilers, or better methods of transmission, but steadier jobs for the apparatus we have, and he who will invent that job will do a better service to the electrical industry than he who invents a new electrical system.

ECONOMIC POSSIBILITIES OF THE MILLING MACHINE.

By Horace L. Arnold.

NOTHING is more surprising than the extreme reluctance with which the human mind accepts ultimate results; the more obvious the result, the more infallibly certain the present coming of this result, the more doubtful we are of its occurrence. Granted that two and two exist, we are very slow to admit that their sum may possibly reach the incredible aggregate of four, and to assert that such is surely the case savors of a radical and hazardous temerity which no soundly conservative engineering intellect can tolerate. We can admit the existence of the stepping-stones; we can even assert that they are firmly supported in the stream of current practice within easy stride of each other; but the stream still flows and eddies noisily about these yet unsanctioned novelties of but few years' duration, and bold indeed is the engineer who dares set his feet upon them with the firm intention of crossing this consecrated tide of current practice, no matter how desirable or easily gained the farther shore may appear.

The one problem of the machine shop is to remove that part of pieces of metal which makes the rough casting or forging differ from the finished work. How to quickest cut away what we do not want, and be sure to leave what we do want, of a given mass of metal is the constant question of the engine and machine builder. We know that we must use tools to shape metal: our fingers and teeth are not equal to the task. The hammer, first of tools, and fully accepted as legitimate, is the first resort; the chisel is next brought into action; the two are boldly combined in operation, and slowly but surely the outline of the piece of metal is brought to the drawing. Should the work be too slow, two hammers and two chisels in the hands of two workmen may be used; and, if the construction still lags, more hammers, more chisels, and more men may be put upon the work so long as room can be had for effective action on the piece. Not so very long ago the hammer and chisel, supplemented by the file, were the only tools by which the metal-worker could produce flat surfaces on pieces too large to be swung on the face plate of the lathe. Then the chisel was put in a metal hand or holder; the tool-holder was guided to travel in straight lines and pushed over the work, cutting portions of the metal away as it traveled; and two tools, three tools, and even four and five planing tools, each held in a

head of its own, were made to work the same piece of metal at the same time. Long before the day of the planer the mill was known in the finely-toothed form but little removed from the file. In the file we had a multitude of teeth combined, each tearing off its small particle of the metal surface over which the file was pushed. From the flat file in the hand to the disc file in the foot-lathe was not, seemingly, a very long step, and it was made no one knows when,—probably thousands of years ago. It speaks well for our respect for tradition and established practice that we still keep the mill in its old place of a revolving file, useful to slowly remove little chips from metal, and that the very best and most advanced of modern toolmakers do not yet admit that it is very soon to be the almost exclusive agent in all metal-surfacing operations. Yet such is certainly the case, and as surely as two and two make four, just so surely will we soon look back on our present use of the planer in all large metal-surfacing operations with the same complacent pity which soothes our vanity as we picture the early machinist chipping his meager "spots" and "fitting strips" laboriously into the line of his straight edge and level.

With the hammer and chisel the time limit of production is fixed by the number of chisels which can be brought into effective use; with the planer the time limit is fixed by the number of tools which can be brought into position to cut the work at the same time; very rarely over five; so rarely that not a single case can be recalled in which more than five planer-tools have been seen by the writer in simultaneous action upon the same piece; commonly but one.

But by the use of the mill a great number of cutting edges may be brought into simultaneous action on pieces of limited extent.

Can we, then, by the use of this indefinitely multi-toothed tool, indefinitely decrease the time limit of metal-surfacing?

The engineering talent of the whole machine world by its practice answers this question in the negative, and sticks to the single- or double-tooled planer with that fine conservative respect for established practice which distinguishes sound engineering from the crazy ventures of the inventor, whose very name is a reproach.

In the case of the hammer and chisel and the diamond point in the planer-tool post, one and one make two, and two and two make four, but the reputable engineer does not admit so bold an assertion when applied to the teeth or cutting tools of mills.

Yet there are constantly increasing examples of mill practice which show that output may increase with the number of cutting tools in simultaneous action, just as surely and infallibly in the case of mill teeth as in the case of chisels and hammers, or diamond points in planer-

tool posts. There are cases where cast iron has been surfaced on the milling machine forty times as fast as the same pieces were surfaced on good planers. Brown and Sharpe have cut a 60-tooth, 6-in. face gear, 3 diametral pitch, inside of 30 minutes, feeding at the rate of about 18 in. per minute. Brooks has built a milling machine which can finish one side and two edges of a piece 20 ft. long × 100″ wide × 20″ deep, at one operation. Ingersoll has operated one of his mills in one of his milling machines for eight hours with a feed of over ¼″ per tooth on cast iron. With the Brown and Sharpe feed of 18″ per minute on the Brooks machine a piece of cast iron 20 ft. long, 8 ft. and 4 in. wide, and 20 in. thick could be surfaced on one side and two edges inside of half an hour, at a total cost, including everything, of less than one dollar.

Yet not even milling-machine builders dare to admit that such astounding cheapness of metal-surfacing can be had. The facts are beyond dispute, but two and two cannot yet be admitted to make four on the milling machine. The stepping stones are firmly placed, but no engineer dares risk a tumble and splash before the public eye by walking on them.

All engineers are perfectly ready to admit that in the production of small interchangeable parts the milling machine is indispensable, but not one can be found to say that the day of the planer has passed.

The milling machine can make the rifle, the sewing machine, the type-writer, and even the engine lathe bed, but it cannot make the steam engine, the locomotive frame, or any general machine work of magnitude.

What are the causes of this profound distrust of a machine which promises to reduce the cost of metal-surfacing to say one-tenth of the best that can be done with planers?

The limits assigned to this article are not sufficient to contain a fully-detailed answer to this question, and to fortify such answer with full proof of its correctness. There are two forms of mill cut by which mill teeth act upon metal. The first is that of side-cutting mills, in which the teeth act precisely as the paddles of a side-wheel steamer act on the water, and the other the end-cutting mill, in which the mill teeth act exactly as a plow turns a furrow in earth; generally speaking, the paddle-wheel cut requires vastly more power to remove a given section of cast iron than is needed by the plowshare cut, and, to produce their best effects, both forms of mill cut require very great powers of resistance in the milling-machine framing. The form and angles of the teeth of the two principal varieties of mills make enormous variations in the power required to remove a given section of metal by their action; and the resistance of the paddle-wheel form to the feed motion

may be varied, by the direction of mill rotation, from a feed-table resistance, which is overcome with difficulty by the most powerful feed action which the machine can contain, to a very powerful self-feeding impulse, which the feed-action merely regulates by a let-off function. The angles of the plowshare tooth may be such as to either put an enormous thrust on the mill carrying spindle journals, or to relieve the mill spindle of all except rotative or torsional strains. Precisely as a diamond point lathe tool may be so ground and set in the tool post of an engine lathe that the chip cut will force the tool into the metal and cause the tool carriage to have a regular advance, although the carriage feed mechanism is thrown entirely out of action, the mill cut chip may be made to so balance the mill tooth resistances that the spindle driving the plowshare form of mill tooth has actually no side thrust to resist, and no end thrust away from the work. So far as the mill tooth, and the action of the mill tooth on the metal, and the action of the chip cut on the mill tooth are concerned, it is true that there is no radical difficulty existing of any sort to prevent the simultaneous use of all the mill teeth which can be brought to bear on a given work surface; and each tooth may cut a chip as thick as the single planer tool of equal strength can remove from the same metal; and it need take no more power to drive a single mill tooth than is required to drive a shaper ram carried tool making the same cut, which is almost invariably greatly less than is demanded for an equal cut made on the planer. This assertion that a mill making a cut say 24" wide in grey iron requires no more power than would be needed to drive a planer table carrying the same piece acted on to the same depth by a sufficient number of diamond points or other roughing tools, to cover the entire surface at one cut at the linear feed speed of the milling machine table, will meet with instant denial from some engineers of experience: it must, however, be given here as an unsupported assertion, although the writer is certain of its truth. Many experimenters with milling cuts have failed to discover the most important facts of the mill tooth shape problem, and the paddle-wheel action is almost always investigated in preference to the plowshare action, which will very soon be recognized as the better form, and also the form which lends itself most readily to the production of section contours demanded by the machine constructor. Passing all of these points, each of which might rightly take more space than this entire paper, a very brief consideration of the chief types of milling machines must be had. These types are three in number: (1) the "Lincoln," or ordinary manufacturing milling machine, of which Pratt and Whitney alone have built considerably more than five thousand; (2) the pillar and knee form, most widely known in the Brown and Sharpe "Index" milling machine, to be found in every tool

room of every machine shop in the world of any pretensions, and adhered to by Brown and Sharpe in their larger machines for finishing cast-iron surfaces; (3) the planer form, adopted by Brooks in his unique example, and by Ingersoll as a regular line of manufacture.

Types one and three are framed to give the mill carrying spindle support on both sides of the mill; type two is not framed with that view in the construction of its principal members, and the out board mill spindle support of type two is of the afterthought description, and, although effective for a range of cuts fully up to present practice, does not present such original structural facilities for mill support as do the "Lincoln" and "Planer" framed milling machines. All three of these types of machine are adapted to use both the paddle-wheel and plowshare action mills, although Brooks does use the plowshare (end mill) form only. Pratt and Whitney,[6] Brown and Sharpe, and Ingersoll use either form of mill indifferently, Ingersoll perhaps fully equalling either of the others in design so far as efficient mill support is concerned.

The problem of the milling machine frame is really this: given full elements of planing machines which long practice has proved equal to the support of say three or five cutting tools covering say a finished surface of $\frac{3}{4}''$ or $1\frac{1}{4}'' \times 15$ or 20 ft. per minute, it is required to find the elements of the milling machine construction, which shall drive and support a sufficient number of cutting tools to cover in one case the greatest width of piece the machine will take through between its mill arbor supports, or, in the case of the Brooks machine, two very considerable side cuts in addition to the full width top cut. The designer at once discovers from the very insignificant power delivered to the planer by its narrow slow belt or very narrow quick belt that he has but few horse powers of effect to resist; he frames and powers his machine in excess of the planer practice, and he produces a tool which is actually capable of doing from six to forty times the work of the single tool planer commonly employed upon pieces of the same class. Clearly the planer might be the more effective tool of the two, as the planer tools might be set closer together, and hence be more numerous than the mill teeth. Suppose a 24-in. planer table to have bolted to it a piece of grey iron 24 in. wide; suppose this planer can carry a $\frac{1}{16}$-in. feed on the depth of cut needed to finish the work; now suppose that, instead of one cutting tool in one tool post, we put in 384 tools ($24 \times 16 = 384$),—there is then no physical impossibility to prevent surfacing this $24''$ wide piece at one single traverse of the planer table, and a piece $24''$ wide $\times$ 20 ft. long could thus be finished in one minute at a total cost of say 5 cents, as against an expense of say $3.00, entailed by the 540 minutes needed to surface this piece

by usual planer practice with $\frac{1}{10}$-in. feed of a single diamond-point tool. The common method would be, were a constant output of such surfaces demanded, to employ a great number of planers, attended by as few hands as possible, and so decrease the labor cost as much as possible. But the single tool planer is not only slow; it is also bulky and costly, and the room and price needed for planer effect compare most unfavorably with the space and cost needed to put an equal number of milling-machine cutting tools in operation on the work which the planers can finish. But the machine tool engineers, as stated at the outset, will not admit the tool for tool comparison between planers and milling machines.

Twenty to twenty-five feet surface speed is about the outside limit for grey-iron planer cuts; this might often be more, and grey iron is milled regularly with cutting edge speeds of 30, 40, 50, and even as high as 60 ft. per minute without harm to anything. Thirty feet is so common that it can be safely assumed as normal. A mill surface travel of 30 feet per minute carries 360 inch pitched mill teeth past a fixed point every minute. Ingersoll, during eight consecutive hours, made each mill tooth cover over $\frac{1}{4}$". Taking one-fourth of this effect as a safe basis, the wide tooth space of 1 in. would give as above $\frac{360}{16} = 22$ in. feed per minute, as possible with an inch pitch mill tooth and thirty feet surface speed. A per tooth feed $\frac{1}{10}$" has been successfully used at a surface speed which gave 40" of linear surface cut per minute. The 5-tool planer can cover (as before) at $\frac{1}{16}$" feed less than $\frac{5}{8}$ of a sq. ft. of finished surface of grey iron per minute. The milling machine, surfacing a piece 24" wide, would, at a feed of 22" per minute, produce $3\frac{2}{3}$ sq. ft. per minute, which makes the effect of the milling-machine to the effect of the planer as 15 is to 88, or nearly 6 to 1. Hence the milling machine might require 6 times the power needed for the planer, even when the planer is using 5 tools, and might be held also to demand 6 times as much frame support for the mill as good practice would give the planer tools. In point of fact, the milling machines are belted (powered) far above the planers, as indeed they must be to drive them at all, while they are not in any case framed more heavily than heavy planers, and in most examples the mill arbor is not so well supported as are the planer tool saddles on the heavy planer cross rails. Ingersoll, adopting the planer type and using a massive cross rail, and Brooks, under precisely the same conditions, give an approach to efficient mill support. Builders of the "Phœnix" and pillar and knee types give much less mill support than Ingersoll and Brooks give, and also give not more than one-tenth the support which the planer tool has in the severest common practice. One and one do not make two, nor do two and two make four,

when the machine-tool designer considers the milling-machine frame stability needed to give resistances equal to those put behind the planer tool. Hence Ingersoll gives a maximum feed of 5″ only in his milling machines, while the Pratt and Whitney, Brown and Sharpe, and Newton practice seldom exceeds 1¼″ at work, and commonly falls below that meager figure. It is true that at the feeds used the milling machine shows a startling economy: it is also true that insufficient framing is the first factor in the current belief that each mill tooth cannot take so great a chip as each planer tool, or, in other words, that two and two do not make four when considered as elements of milling machine work production.

There also exists an entirely unfounded engineering belief that the production of milling cutters must be much more costly than the production of planer tools to cut away a given weight of cast-iron chips. This is an entire mistake. A large, finely-finished solid steel mill is one of the expensive productions of the tool maker's art, but it represents the life of many hundreds of the comparatively cheap planer tools; and especially in the Ingersoll form, and in other inserted tooth forms, the mill is by far the cheaper of the two when possible life-long effect is considered.

Again, there is the belief, founded in ignorance pure and simple, that very expensive and delicately-adjusted assemblages of mills, or "gangs," are needed to produce given outlines of finished work section. The E. W. Bliss Company have been for 20 years producing great numbers of milled press frames, finished by mills which are in no way special, and in no case, in their general work, does the Bliss company use gang mills, as their milling machines are of the slotting machine type, with single spindles, and incapable of using gang mills.

The truth is that by means of simple and perfectly obvious combinations, which are not yet, however, in general use, a few plain small mills may be made to produce milled surfaces of any contour of section which can be bounded by right lines; not, indeed, at one single cut, but at two or three cuts, perhaps, or possibly even more; these cuts being of such width, and made at so rapid a pace, that the work is finished with stock tools, adapted to a host of different jobs, at an average cost not exceeding one-twentieth part of planing prices.

The situation at the present time is exactly this; the milling machine has invaded each of the grand divisions of the old-time engineer's work, and, whether applied to planing, boring, turning, slotting, or vise work, it has in every instance divided the cost of production by a surprising factor. The quality of the work has been in every case improved, and the grade of labor required to produce that

work has in every case been lowered. Yet the conservative engineer denies that the milling-machine can ever be more than a special adjunct to the regular machine shop plant, and refuses to recognize it as a factor in general production. Rapid production is admitted, since so much cannot be denied, but accuracy of surface produced in work of considerable size is still questioned by engineers at large. Bliss produces press frames up to the capacity of his largest machines; Pratt and Whitney mill their lathe beds, V-s and all, with better results than planing ever gave in their shops where accurate planer hands abound. The writer has within a very short time examined steel pieces $10'' \times 1\frac{3}{4}'' \times \frac{1}{4}''$, in which the error limit was less than $\frac{1}{4000}''$ as they came from the milling machine; they were finished at a cost which cannot be given, but is incredibly low when the error limit is considered.

Nothing in the whole round of human affairs is more certain than that the buyer will seek the lowest cost for his purchase. However long and however blindly established practice may be followed, a day finally comes when the most conservative tradesman opens his eyes to the fact that others in his own line are buying finished product at lower prices than his own cost-book shows, and he awakes to the situation.

The time is very near at hand when the milling machine, with its multiple-toothed cutter, will take the place in the general engineer's plant which it has already won in thousands of special instances; large surfaces will be submitted to its action; engine cylinders and frames will be finished wholly by the multiple-tooth cutter, as they are even now in part in many shops; we shall see large structures finished at two passages of the milling-machine table at a total rate of 12 or 15 in. of length per minute, regardless of section, all surfaces, however relatively located, being simultaneously operated upon; and a new factor in machine production will be established, which will effect a greater reduction in cost and improvement in product than that wrought by the general introduction of the planer sixty years ago.

RECENT ARCHITECTURE IN FRANCE.

(SECOND PAPER.)

By Barr Ferree.

And Abraham drew near, and said, Wilt thou also destroy the righteous with the wicked? Peradventure there be fifty righteous within the city. . . . And the Lord said, If I find fifty righteous within the city, then I will spare all the place for their sakes. And Abraham answered and said. . . . Peradventure there shall lack five of the fifty righteous, wilt thou destroy all the city for lack of five? And he said, If I find there forty and five, I will not destroy it. . . . And he said, Oh, let not the Lord be angry, and I will yet speak but this once: Peradventure ten shall be found there. And he said, I will not destroy it for ten's sake.—GENESIS: xviii: 23-33.

THREE departmental cities stand out among the innumerable cities and towns in France as special centres of modern architectural interest Marseilles, Montpellier, and Bordeaux are the three cities in which the most interesting of recent building is to be seen and in the greatest quantity. Other cities are not wanting in modern buildings. Grenoble contains a square entirely surrounded by recent important buildings, and it is interesting as one of the few large squares in France so surrounded. Toulouse has a few modern buildings, though none of importance. Toulon is better representative in this respect. Tours, Lille, and Poitiers have some important buildings: but, with these exceptions, and those of the three cities first named, there are not many French cities that can boast more than one or two important buildings. The larger part of their buildings are either old, and therefore have an interest quite different from that which belongs to new structures, or else so utterly featureless as to be devoid of architectural value apart from their planning and arrangement.

In Marseilles the pilgrim to modern architectural shrines will find a good deal to demand his attention. The main street of the city is a mimic Paris street, with huge hotels hidden behind solemn exteriors, whose forms have the familiar, homelike aspect that one finds in most French cities. In the Palais de Longchamps and the new cathedral the student will find two noble works of the first order,—the one representative of secular art, the other a type of the latest French effort in religious art. The Palais de Longchamps is one of those elaborate compositions that illustrate both the faults and the strength of modern French architecture. It is a superb conception, situated on rising ground at the top of a long street, beautifully shaded with trees.

PALAIS DE LONGCHAMPS, MUSÉE DES BEAUX ARTS, MARSEILLES.

M. Espérandieu, Architect.

The situation is, indeed, ideal, and the architect has made the most of it. In truth, the plan is the better part: the arrangement of the terraces, the sweep of the steps, the fall of the fountains, and the enclosing of the whole with an architectural background that is at once the center and culmination of the design are magnificently planned. The chief defect is in the palaces or the museums themselves, which, while pretentious enough, are not worked out with sufficient care, and are deficient in detail,—that fatal error of almost all French building.

The new cathedral of Marseilles is interesting because it offers so great a contrast to much contemporary ecclesiastical French architecture. Before visiting Marseilles, I had made a pilgrimage to the church of Notre Dame de Fourvière on the hill above Lyons, which, so far as my knowledge goes, is clearly the worst church in the whole world. The basilica of Notre Dame de la Garde, on the heights of Marseilles, is another structure that might be classed with Notre Dame de Fourvière, but it is distinctly superior to it. At Fourvière all the evils of modern French taste are in full blast. The architect has apparently invented everything out of his head; certainly such forms, such combinations, such sculpture, such detail, such color, exist nowhere else on the face of the earth. The crypt is bad enough, and the

THE CATHEDRAL, MARSEILLES.
MM. Vandoyer, Espérandieu & Révoil, Architects.

THÉÂTRE, MONTPELLIER.

finished bay, with all its horror of completed detail, the worst of all: but the upper chapel—or basilica, as it is properly called—is the most intolerable room it has been my misfortune to see. Everything that is bad is here, everything that is offensive to taste and art: everything that an architect should not do has been done in this building. And there has been no stint of money: the materials are of the richest, the decorations the most elaborate: yet in the very centre of this horrible unfinished, costly, extravagant hall is an alms-box, that visitors may, by their gifts there deposited, help on the horrid work! Those gentlemen who, in America, wish for a "modern" church architecture will do well to visit Notre Dame de Fourvière before uttering further fulminations on that subject: there they will learn, if they have not before grasped the truth, of the logical outcome of "modern" ideas in church building.

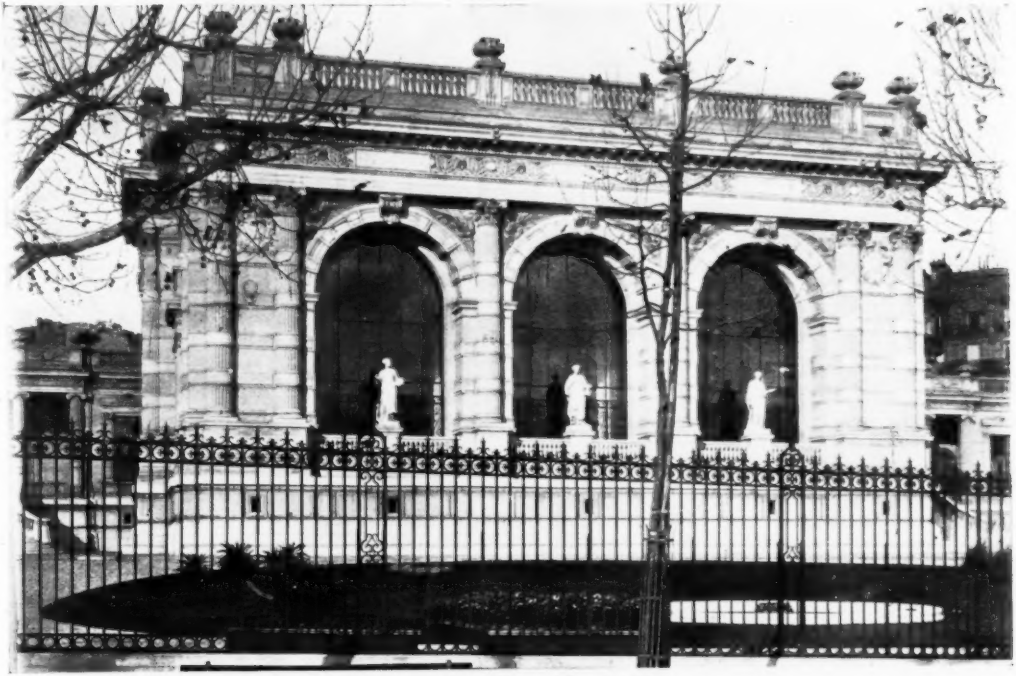
There is nothing of this in the cathedral of Marseilles, which is more impressive within than without, and best seen outwardly towards the east end, where the Lady Chapel stretches away to an appalling length behind the west towers. It is a church of enormous size; and not only is it big, but it seems big,—an impression which the greatest church of the Renaissance does not succeed in giving. The style is not a happy one: it is neither Romanesque nor Byzantine, yet it suggests both. But the interior is grand and imposing: the choir is of aston-

MUSÉE FABRE, MONTPELLIER.

ishing length, with rich architectural perspective; and in the over-powering interior the architect has obtained a result that almost compensates for the unpleasant features of his exterior. It is not an impression one expects from the outside of this church, but of its type it is the most successful church in France. The church of Montmartre at Paris, with which it may best be compared, does not approach it in grandness of effect. This last church, by the way, is a sad illustration of the manner in which the French can entirely throw away an opportunity when they feel disposed to do so.

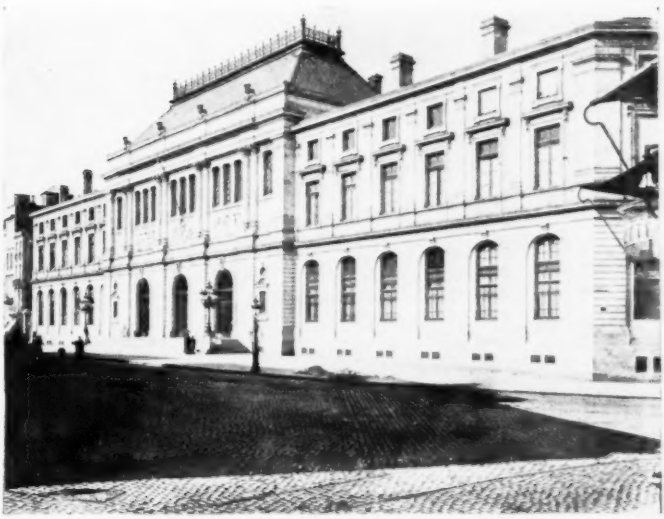
Montpellier I visited with special interest. I had been told by an eminent Frenchite at home that it was "fine," and I earnestly hoped I would think so too. My preliminary drive around the city told me why he thought it was fine, and told me as well that the fineness was of a sort I could not myself appreciate. Of all the French cities I have visited Montpellier is the newest and the most up-to-date. The student of modern architecture will here find no single masterpiece that will

PRÉFECTURE, MONTPELLIER.



MUSÉE GALLIARA, PARIS.

M. Ginain, Architect.



FACULTÉ DES LETTRES ET DES SCIENCES, BORDEAUX.
M. Durand, Architect.

compare with the great buildings of Paris, Marseilles, or Bordeaux, but in very much less space than in any of those cities he will be able to study his art in many very good examples. The Théâtre, which has but just been finished, is a quiet and stately design, entirely devoid of eccentricities; the Musée, the Préfecture, the Palais du Justice are all in the same quiet, good taste; and, above all,—I presume this is the proper gradation,—the streets are lined with shops and dwellings of the most approved Parisian type. Could anything be more delightful? And verily the town is a gem in its way, and illustrates just what the modern French architect can do when he has a reasonable amount of money to spend and a tolerable opportunity to utilize his talent for design. By the time I reached Montpellier I had visited nearly fifty cities in France, and everything seemed so delightfully homelike and familiar! Whatever French architecture does, it at least prevents the traveller from feeling a stranger and alone in distant cities. When one can tell beforehand how the buildings that he is about to see will look, a great deal of saving is effected in the nervous system; one is not liable to the shock of new ideas and strange sights.

If Montpellier is "fine" to see from the Frenchite standpoint, Bordeaux is certainly magnificent. Here is scarcely an arch that is not round; scarcely a window that is not encased in a frame of its own;

THÉÂTRE, ANGERS.
M. Magne, Architect.

hardly a floor that is not marked off by balconies on corbels or brackets of the most approved type; hardly a window without its grille; scarce a façade without its pilasters: in fine, not to exaggerate, and barring some ecclesiastical edifices, scarcely a structure that does not, in some shape or other, in some form, detail, or general design indicate the sacred and penetrating influence of the School manner. I would not say that Bordeaux is the best city in which to study the consecrated influences of that cult, but here at least it may be studied in multitudinous —if not always happy and successful—results, though not always in the latest and most approved style.

Perhaps the most notable single modern building in Bordeaux is that of the Faculté des Lettres et des Sciences. This is a large and spacious structure, the main front consisting of a well-designed and admirably-accentuated central pavilion, and two long wings treated with considerable severity. The central pavilion is a very well-thought-out piece of work, but the wings, with their insufficient detail and their shallow pilasters, are excellent types of that poverty of resource noticeable in so much new building. The most conspicuous error in the design is in the basement windows, where, after providing large and ample arched openings, the architect has filled them in at the side, apparently because his window-frames did not fit. In the centre of the adjoining lateral façade is a group of basement windows, in which the sash fills the whole space allotted to it by the stone construction; and the contrast between these windows and the pieced-out ones is very striking.

Nearly every French city contains four buildings of more or less monumental interest,—the Hôtel de Ville, the Palais de Justice, the Théâtre, and, if it be the chief city of a department, the Préfecture. So persistently have the problems presented in these four structures been solved by French architects that well-defined types of each of them have been evolved. The Hôtel de Ville has a central pavilion, a tower in the middle, two projecting wings, and a high roof. The Palais de Justice, in its latest form, surrounds an open court, and is usually entered through a stately portico. The Préfecture, being a residence, offers greater variety, and has not yet been reduced to as definite a type as the others of the group. The Théâtre has, to some extent, been influenced by Garnier's great design for the Paris Opéra, but many of the smaller theatres show considerable departure from that superb type. Thus the Théâtre at Tours—one of the most recent in France—suggests no hint of the Opéra. It is not fortunately situated, the longer side being on a principal street, which is itself narrow, but is luckily cut by a side street, directly opposite which the central feature of the façade has been placed. This is a high arch, under a frieze carried by two engaged columns on either side, capped with a broken curved pediment, in the centre of which is a sculptured group. On each side the wall is divided into bays by shallow pilasters, with large

LA BOURSE, LE HAVRE.
M. Lemâitre, Architect.

THÉÂTRE DES ARTS, ROUEN. M. Sauvageot, Architect.

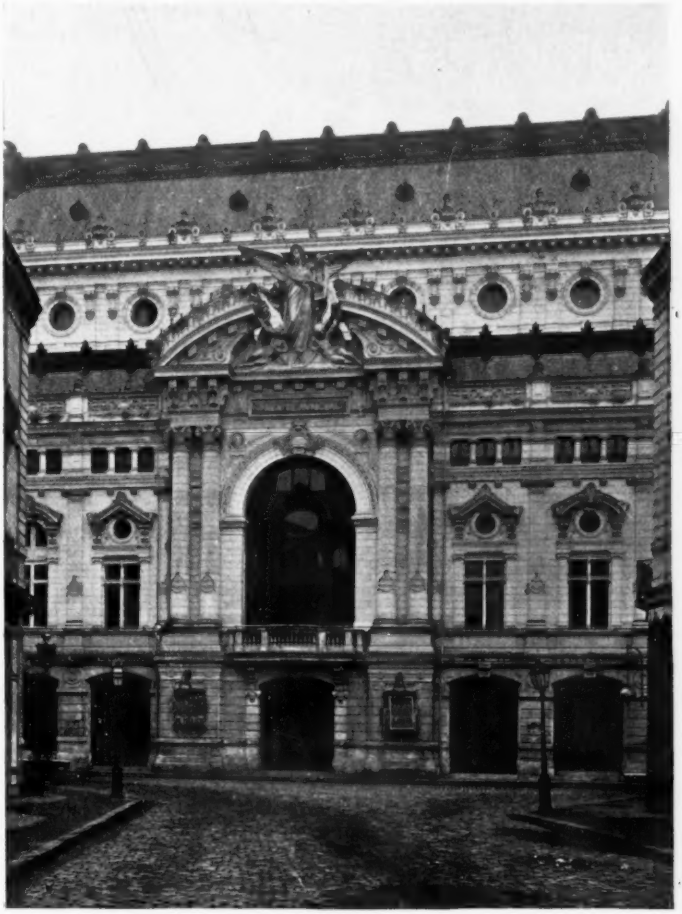
THÉÂTRE, MONTE CARLO. M. Garnier, Architect.

MAGASINS DU PRINTEMPS, PARIS. M. Lédille, Architect.

monumental windows between them, and at the top is a smaller series of windows, which is actually the frieze of the wall. The ends are formed by smaller pavilions similar to the central one. All of this is, of course, carried on a plain basement, which has segmental arched openings. Above the roof is an upper wall, or clearstory, lighted by small circular windows, and the whole is crowned by a high curved roof. The design is interesting both for itself and for its wide departure from the typical French theatre design.

The Théâtre at Angers shows another type of design. The central feature—three large windows separated by Corinthian columns—is flanked by small ornamental pavilions containing niches for statuary, and capped with curved

pediments. These are repeated on the outer side of the large intervening arched windows, but with pilasters substituted for the engaged columns. These outer pavilions support small ornamental domes, while the central part has a broad frieze with circles containing busts, and above them a frontispiece with a large semicircular window and a curved pediment over all. This last quite hides the domes which mark the



THÉÂTRE, TOURS.

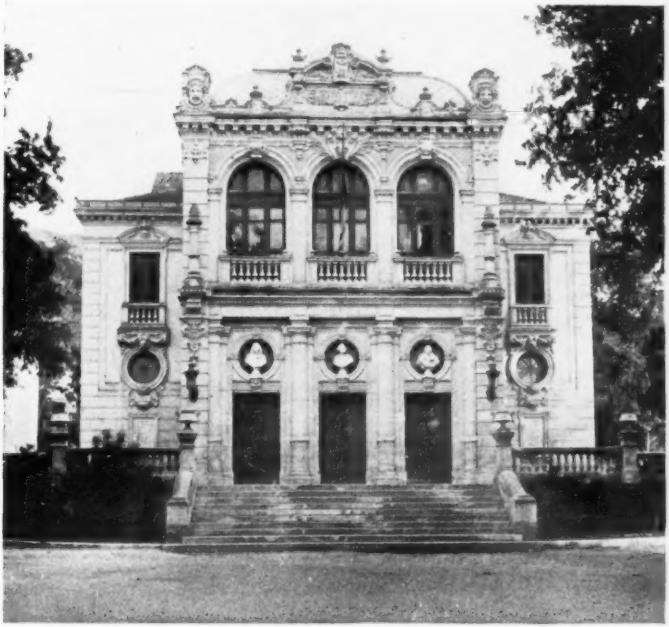
PALAIS DE JUSTICE, PARIS.
Façade of the Cour de Cassation. E. Viollet-le-Duc, Architect.

interior plan of the building. On each side are plain wings, whose lower portions are given up to business, this being one of the rather rare instances where commercial necessities are considered in conjunction with the purely pleasure giving function of a theatre. On the whole, notwithstanding the false top-piece, the architect has managed his commercial-pleasure combination with great ability. It should be noted that the two bulletin boards built into the piers on each side of the entrance, apparently for playbills and other notices, are not used for that purpose, rough board bulletins being placed below them.

Commercial architecture in France has nothing in common with commercial architecture in America. It is a purely French product, treated in a purely French way. Huge blocks of buildings, whose lower floors are given up to shops and cafés, and whose upper floors are used as flats, are often designed with some richness of detail, even though in itself it be poor and insignificant. Framed windows, with or without pediments, can usually be depended on, while nearly every floor will have its own balcony carried on carved corbels. These corbels have a singular uniformity in design: at their base they hug the wall as though stone were scarce and projection expensive; but, suddenly, just under the balcony, they shoot forth into space as though their purpose as apparent supports had just been remembered, and the designer is seemingly so happy in the thought that he did not forget

what he was about that he quite neglects to readjust the lower part of his brackets to his upper.

It need not be said that buildings of such a type scarcely suggest the commercialism that American business buildings do. They seem rather to be extensive blocks of dwellings whose lower floors have been turned into shops, than structures whose commercial ends were considered from the very outset. Even a gigantic place of business like the Hôtel of the Crédit Lyonnais in Paris—the largest private place of business in the capital, save the commercial emporiums—suggests nothing of the utilitarian ends for which it was built. Of the great dry-goods shops of Paris the most successful is the Magasins du Printemps. The Magasins du Louvre occupy an old hotel, and are as inconveniently arranged as it is possible to imagine. The Magasins du Printemps were built expressly for their present purpose. It is an interesting combination of stone, iron, and glass, with just that superabundance of ornament that only a Frenchman would think of applying to a commercial building. As a study in iron and stone, it



THÉÂTRE MUNICIPAL, ORANGE.

CHÂTEAU GAILLARD, PLACE MALESHERBES, PARIS.

M. Fevier, Architect.

is a far greater success than the singular church of St. Augustine, where the efforts of a "new architecture" are appallingly illustrated. It teaches a warning to those who wish to show iron when it is used in combination with stone that only the blind can ignore. Fortunately the experiment is an internal one; it need not be seen unless one goes within.

The eccentricities of modern French architecture are never seen to better advantage than in the dwelling-house. Few dwellings call for monumental treatment, though few French architects appear to be alive to that fact. Or possibly it is that here he reserves his skill for the production of the eccentric and the grotesque. The block dwelling in the city has already been referred to, and may be seen all over France with scarce a variation. The individual house is sometimes of considerable interest, though it is more apt to fall into the error of grotesqueness and over-enrichment of ornament. The single house is best seen in Paris, there being few really notable houses in the provincial cities, though a fine modern Renaissance house in Béziers may be noted in passing. Paris contains some good houses in the newer parts: the charming house of M. Gaillard on the Place Malesherbes may be cited as one of the most delightful of recent French domestic designs. The motif is the Château de Blois, and has been handled with consummate skill, the front being low and broad, with refined detail. The design is in striking contrast, in its stately beauty, to some recent pretentious houses in New York based on the same motif.

That there is much that is good in current French architecture, much that is fine, and some things that are great, it is folly to deny. On the other hand, it must be admitted, even by the sturdiest defenders of the French system, that the actual buildings do not come up to the standard of the School work itself. With this I would place the further statement that the quantity of interesting work, or of even tolerable work, is quite out of proportion to the reputation of the School. In other words, when a country maintains a costly system of education in architecture; when the great prizes of government building can only be gained by graduates in that system; when architecture is so much thought of that its management becomes a bureau of the national government,—something more than an occasional fine building should be found as a result. The land of France should be dotted with great works in architecture, instead of boasting of perhaps not more than a single half-dozen. The success of the School of Fine Arts is to be gaged by the actual buildings erected under its inspiration; not by its claims as to the benefits it confers upon its students. If the system is not strong enough to bear the test of experience; if its students cannot remember its lessons sufficiently well in the

COMPTOIR D'ESCOMPTE, PARIS.

M. Corroyer, Architect.

provinces and the smaller towns to live up to its teachings,—then surely we are justified in writing the word Failure across its record-book, and nothing remains but a winding-up of its affairs, and a disposal of its effects at the Hôtel Drouot.

It is not too much to ask for the maintenance of the very highest ideals in architecture in all important buildings in France. In no other country are the conditions for the production of fine work so admirable; in no other land does the art stand closer to the people; in no other land—it is scarce an exaggeration—are so many remains of fine old buildings with which new ones may be compared; in no other land are the architects better trained or more fitted for their work. Yet, with all this extraordinary array of favorable circumstances, the modern architecture of France, taken as a whole, is no better than in any other country, and in very many cases it is distinctly worse. Its architects lack balance, as when they overload their buildings with ornament; they lack appreciation, as when they fail to endow their buildings with feeling, which is one of the greatest, if not the greatest, of architectural properties; they lack reasonableness, as when they try their hands at the invention of Orders and detail; they lack refinement, as when they refine their ornament and detail to such a degree as to make the work actually deficient in projection and mass; they lack sobriety, as when they cover their walls with pilasters, break up their fronts into unnecessary masses, and add meaningless appendages in the hope of ornamental result. That all these things may not be found in every building; that some are more noticeable than others,—does not affect their general prevalency, or diminish the fact that, alone and together, they weaken the position of French architecture. It would be bad enough did such a state of things exist where the conditions were less favorable to the production of good buildings; it is absolutely intolerable that it should be the fact in France.

Not the least preposterous claim made for modern French architecture by its votaries in America is that it needs to be understood in order to be appreciated. One needs to "get into the spirit" of modern French art before one can properly value its architectural form, we are told. Then everything will be lovely, and the newly-acquired convert can join in the chorus of self-adulation indulged in by his elders and betters. I do not know whether the French themselves make this claim or not; I suspect they are too shrewd and endowed with too much common sense to tolerate such nonsense. Does current architecture in France,—architecture built by men living in our own time, under conditions we all can make ourselves familiar with, in ways and according to standards that have no occult properties of their own,—does such an architecture require a key and handbook, a

course of lectures, a guide, a written explanation and decipherment, in order to be understood and appreciated? In some senses this may be true, for personally I find it quite impossible to follow some of my would-be guides in their admiration and enthusiasm for particular buildings. But surely never before was an architecture created of which such claims have been made. Architecture is not a closed book, not a thing distant from common folk (like myself), not something to be approached with bated breath and bared head, but an art that, more than any other art, stands close to people's lives,—an art that is nearer to human necessities, and does more for human safety and comfort, than any other form of art. There are no guides needed to the mysteries of modern architecture,—no signboards, no explanatory notices. If it cannot be seen and understood in the seeing, then it cannot and does not exist.

In the Opéra in Paris modern French architecture possesses one of the greatest triumphs of the art in this century. Faultless the building is not, but it is so grand an achievement, it is so superbly thought out, its designs so thoroughly reflect its planning and arrangement, its detail is so rich and lavish, and withal so good in itself, that one can approach it filled only with admiration for the man who designed it, with respect for his genius, and with admiration for his art. The Hôtel de Ville in the same city is another matchless monument which can only excite admiration and surprise that so superb a work could have been carried to successful completion. And in the Musée Galliera one of the most noted of living French architects has given to the world a building so refined, so graceful, so beautiful, so charmingly planned, so harmoniously composed, so exquisitely decked out with ornamental detail, that one can scarce find words wherewith to properly express one's delight in it. This veritable jewel among modern buildings is so delightful and exquisite that one feels almost tempted to forgive the system that gave its creator the skill to produce this masterpiece.

But we need more than a single Opéra, more than a single Musée Galliera, as the result of a lifetime of two hundred years. The School and its pupils should have more to show for themselves than these two buildings, great and noble though they be. It needs more than a few important government buildings in Paris to excuse the enormous expenditure the maintenance of the School has entailed in its two hundred years. The taxpayer of France, if no other person, has a right to demand more than an opportunity to train a few men of genius, and to ask for more than a handful of masterpieces,—literally less than one for each generation the School has lived. France should be filled with noble buildings of the very highest excellence of archi-

tectural art. The example of the School of Fine Arts should be seen in every city; the power of its graduates should be manifested at every point. It should have more than a series of portfolios crowded with students' dreams as results. Taking the School as it stands, valuing its work as its pupils value it, elevating it to the exalted position given it by its American admirers—and this is perhaps as high, humanly speaking, as it can be got—there is nothing that cannot be demanded of it, no standard suggested that it cannot live up to. Yet, met on its own ground, it fails to come up to even the lowest limit of number and quantity, or to meet the most lax requirement of art and excellence.

Will the apologists for the School of Fine Arts produce an Abraham who will plead its cause in the number of its works? It is quite time he appeared, and his task is not one to be envied. Yet the very appearance of such a defender will be an admission of failure, a confession of weakness, an indication of shame. With all its vaunted energies, its boundless resources, its favored circumstances, the School of Fine Arts has not yet been able, after nearly two hundred years of continuous existence, to provide a general architecture for its own land that approaches, in any notable degree, the standard it itself sets for the paper work of its own young pupils. Its graduates and its professors are alike in their inability to competently handle the problems of real architecture with the same grace and facility with which they handle paper designs. Even the students in the School recognize this fact, since in their studies it is not erected buildings they take as their models, but the designs of their own predecessors prepared on paper for no other purpose than to be handed around and looked upon. Every modern building in France might be swept away, and, if the portfolios of the School should remain intact, it could still carry on business in the same old way, quite undisturbed by the physical change that had devastated the country.

The traveller in France, who wanders conscientiously from town to town, from department to department, seeking after the monuments of modern French architecture, and finding none, must conclude his journey with a feeling akin to stupefaction. How, with so little to show for it, with such inefficient designs, such thinly-scattered notable buildings, has the School of Fine Arts, Rue Bonaparte, Paris, gained such a tremendous and world-wide reputation? We are occasionally afflicted, in this unartistic land of America, with the blowings and trumpetings of advertisers and advertised articles. No American product, property, or possession, has ever been boomed with the strength, the persistency, the constancy with which the French School of Fine Arts has been boomed. And no product in the whole world has less solid ground behind it to excuse the uproar made on its behalf.

LESSONS OF THE ELBE DISASTER.

By Robert Gillham.

THE distressing accident to the steamship Elbe of the North German Lloyd Steamship Company, which was sunk in the North Sea immediately following a collision with the British steamer Crathie on January 30, 1895, resulting in the loss of three hundred and fifty lives, has made a deep impression on the civilized world. Much has been written about the safety of ocean steamships and the security found in the use of the modern transatlantic service. The success of the service is truly remarkable in view of the great improvements in steamers, securing great speed and superior comforts, and at the same time greater security against accidents. When great loss of life occurs at sea, due to accident or storm, the public look with horror on the perils of the ocean, forgetting for the time the horrors of a Johnstown flood, the forest fires of the North, the cyclones of the West, or conflagrations in cities, in all of which many lives have been lost. The loss of the Elbe will cause no more reduction in travel on the ocean than a collision on a railway causes in the use of railway trains.

The introduction of water-tight bulk-heads in the construction of modern steamships, sub-dividing transversely the hull into a series of water-tight compartments, inspired greater confidence in the safety of ocean steamers. The sinking of the Elbe will result in many inquiries with reference to the value of her transverse bulk-heads, and will, no doubt, when the facts are known, prejudice the minds of many against those steamers having bulk-heads with doors through them.

We are informed that the Crathie struck the Elbe at a point where a bulk-head separated one compartment from another, and where the bulk-head joined the shell of the steamer, thus making it impossible to save the steamer on account of the rapid inflow of water into two compartments at the same time. This conclusion should be accepted with caution, for the reason that the flooding of any two compartments, where the same are of limited capacity and properly designed, and do not cover too much of the steamer longitudinally, would not cause the sinking of the steamer, unless the bulk-heads separating the adjoining compartments had doors or other openings in them which, owing to the confusion following the accident, were left open, allowing the inflowing water to flood other compartments, and consequently the entire hull below water line, and thus causing a rapid sinking of the steamer. The facts indicate that the latter conditions were true in

the case of the Elbe, as she filled very rapidly, and sank before many of the passengers and crew could be saved by launching the lifeboats.

Marine architects, in order to secure the greatest possible convenience, have in many steamships designed transverse bulk-heads with doors so constructed that, in the event of accident threatening to flood the steamer, they can be closed and the compartments be made water-tight.

It adds to the attractiveness of a steamer to be able to walk two-thirds of its length through an electrically-lighted passage-way between staterooms, passing through doors from one compartment to another; but, when these openings are below water line, the value of the bulk-heads is greatly lessened. They are still valuable in giving stability to the structure of the steamer, but any opening in a transverse bulk-head below water line is an added element of danger in the event of flooding of the compartments.

Accidents at sea occasion more or less excitement and disorder. No matter how competent the officers may be, or how thoroughly the crew may be drilled, it often happens that members of the crew delegated by the officers to perform important duties after an accident, fail utterly, on account of their excitement, to carry out the instructions; and serious consequences follow. The accident to the steamship Oregon a few years ago, off Long Island, is a case in point. A small sailing vessel drove a hole through her shell, and water began to flow in rapidly. The crew failed to close the doors in the bulk-heads, and the water could not be confined, resulting in a general flooding of the steamer and causing her to sink in a very short time. A smooth sea, and vessels near the scene, prevented serious loss of life.

Accidents other than collisions have occurred that have broken the shell; consequently there are dangers to be feared other than that of running into a great iceberg, steamer, or sailing vessel in a dense fog or at night. The case of the City of Paris is interesting. In March, 1890, when about 240 miles from Queenstown, the low-pressure cylinder of the starboard engine, through defects in the securing of the piston to the piston-rod, was broken to pieces. The high-pressure engines working with the low-pressure engine ran away, when the low-pressure engine's piston broke from the rod, reducing a large portion of the machinery in the starboard engine-room to scrap, and at the same time knocking a hole through the bottom of the steamer 20 ft. below water line. The flow of water through this opening was very rapid, requiring only a short time to flood the engine-room. It was supposed that the accident would not result seriously, for the reason that, the steamer being provided with duplicate engines and twin propellers and having also entirely independent engine-rooms, separated

by a water-tight bulk-head arranged longitudinally along the inner side, the inflowing water ought easily to be confined in the starboard engine-room, while the steamer continued its journey to Queenstown by means of the port engine. These hopes were soon abandoned when it was discovered that the port engine-room was filling with water almost as rapidly as the starboard engine-room. A door which had been placed in the longitudinal bulk-head between the engine-rooms was opened shortly before the accident, and some one forgot to close it. There was also a hole broken in the bulk-head when the starboard engine went to pieces. Here were two 10,000 h. p. engines absolutely useless under from 16 to 20 ft. of water. Besides these great engines, the electric-light generators, the circulating pumps that operated the steering apparatus, the machinery used in loading and unloading the vessel, and that used in dropping and raising the anchor, all of which were operated by hydraulic machinery controlled by pumps located in the engine-room, were disabled. The vital parts of the ship were submerged. No light at night, save a few oil lamps and tallow candles. The accident to the City of Paris to some extent demonstrated the fact that it is unwise to concentrate all the auxiliary machinery and pumps in the engine-room. The nine hundred persons on board at the time of the accident can thank water-tight bulk-heads and a calm sea for the preservation of their lives. The transverse bulk-heads in the Paris had no openings or doors below water line. If communication became necessary between compartments, passengers and crew were required to go up-stairs to the main deck above water line, and down again to the compartment with which communication was desired. In the opinion of those competent to judge and familiar with all the facts, the Paris would have gone to the bottom within a short time after the accident, had there been doors in the bulk-heads, as it is very doubtful if they could have been closed in time to avoid a general flooding of the steamer. The Paris floated about helplessly at the bidding of the wind and waves, first on the crest of a great swell, then down in the trough of the sea, drifting slowly with the ocean current from Tuesday afternoon until the following Friday before relief came. The passengers did not leave the steamer until Sunday. Each day added many tons of water to that already in the steamer, until something over three thousand tons had flown into her and flooded the compartments abaft the engine-rooms. The steamer settled lower and lower as the days came around, and, while there were no openings in the transverse bulk-heads, the water forced itself into the compartments abaft the engine-room principally through the man-holes used as means of access to the shaft alley. The shaft passed from the engine-rooms to the stern tube through a water-tight steel casing called the shaft alley, which ran through the com-

partments abaft the engine-room, but was shut off entirely from them except where shaft bearings were located, these man-holes being provided, with man-hole plates tightly secured to the casing. When the engine-room became flooded, there was nothing to prevent the water from running back through the shaft alleys and below the compartments abaft the engine-room to the stern tube where the shaft leaves the hull of the steamer. The head of water in the engine-room was so great that it forced the water under the man-hole plates out into the compartments referred to, and it was not long before these compartments were partly filled with water. Another source of trouble was found in the weakness transversely and lack of rigidity of the bulk-heads under water pressure. The leakage in some places between the plates was considerable, when they should have been absolutely water-tight. This was particularly true where large areas of the bulk-heads were exposed without intermediate supporting plates or angles. The steamer settled until she drew 33 ft. of water at the stern and only 16 ft. at the bow, or 17 ft. more at the stern than forward. She would have gone down stern first, as did the Elbe. Such was the condition of the Paris when towed to Queenstown.

Here we have a case where a steamer provided with the most improved bulk-heads, flooded as described, could not have weathered a storm or remained above water very much longer without aid.

It is important to so improve the water-tight bulk-head system in steamships that one compartment may be flooded without in any manner endangering the other compartments. Many believe that this result has already been secured; but, when leaky seams, and light construction, and weak plates, and doors or other openings in bulk-heads and shaft alleys are considered, it is evident that there is room for further progress. The best practice is opposed to openings of any kind in the bulk-heads below water line, favoring means of access between compartments only above water line.

The writer once suggested that special means should be supplied, if possible, that would effectually exclude water from compartments after flooding. If this can be accomplished, greater safety will be secured to the service.

The vital parts of a steamer, or engine- and boiler-rooms, should be so arranged that, in the event of either being flooded, they can be closed and made air-tight. Steamers should be provided with air compressors, and perhaps auxiliary steam-supply of small powers. The compressed air should be forced into the flooded compartments at such pressure as would expel the sea-water through the openings in the shell back into the ocean, after which the repairs necessary to permit the steamer to proceed could be made to either machinery or shell.

If necessary, the engine-room or compartment repaired could retain air pressure until port was reached. By the use of temporary air-locks as means of access to these compartments, there would be no difficulty in operating these rooms, and no trouble in working men or machinery under considerable air pressure. Any compartment could be treated in the manner described, if properly arranged. Had it been possible to close the sky-lights above the engine-rooms of the Paris, and make the engine-rooms practically air-tight, compressed air at a pressure of about 10 lbs. to the sq. in. would have expelled nearly all the water from the engine-room; the bulk-heads between the engine-rooms could then have been repaired, the door closed, and the port engine used for the purpose of reaching port. There was no difficulty or trouble with the port engine, and, if the water could have been kept out of the port engine-room until the bulk-head between these rooms had been repaired, according to the theory upon which this steamship was built, the port engine could have been operated, even though the starboard engine-room was flooded. After forcing the water by air pressure from the starboard engine-room, if it had been discovered that repairs to the shell could not be made, the air pressure could have been maintained in the engine-room, which would have kept the water from returning into the room. The practical application of suggestions here made is, of course, surrounded with many difficulties, and I doubt not naval architects and practical shipbuilders can cite objections seemingly insurmountable. But, in the light of events, and from a logical standpoint, the use of compressed air in excluding water from compartments flooded on steamships is worthy the closest consideration. A careful study of the subject may develop practical methods for its introduction, not only on ocean steamers, but on ships of our navy, for the purposes indicated. There can be no question that there is great room for improvement in providing special means for the safety of life on ocean steamers: and, in considering improvements in the construction of transatlantic steamers, methods of construction may be developed that will practically make the steamers unsinkable and secure a much higher degree of safety.

GOLD PRODUCTION IN COLORADO.

By W. C. Wynkoop.

WHEN the price of silver fell from 80 to 60 cents per ounce in the summer of 1893, the effect was remarkably severe upon the industries of Colorado. Directly and indirectly three-fourths of the population of the State depended upon silver mining. Gold mining formed but an insignificant part of the great industry. At once silver mines closed down, and in every mountain town and camp crowds of men were thrown out of work. The feeling was one of dismay, or desperation. Men who were single packed their few things into bundles and started, generally on foot, for some other region, in search of work and wages. Few of those who had money would pay it to railway companies for fare, and often crowds took possession of railway trains and were hauled for nothing. For a short time the trouble on the railways became so great from the crowds who were "beating their way" that the companies issued orders to conductors to carry free those men who were leaving the country, and who were unable to pay fare. Some mining camps, of minor importance, were entirely depopulated. The freights on the railways naturally fell almost to nothing. On some of the branches from main lines into mining towns or camps the daily train gave way to a semi-weekly or weekly train. In every department of industry where men are employed, there was a partial or entire stoppage. The unemployed crowded into the larger cities, in each one of which measures for their relief were adopted.

In the mining regions those who had families, or who owned property, were practically the only ones who remained. To make a living, or get something to eat for their families, they were obliged to take leases, or go "gophering" around among deserted mines and prospects, getting a little ore here and there, out of the sale of which, even at the greatly reduced silver prices, they could buy the bare necessities of life. The leasing system, then enforced by the impossibility (in most cases) of paying wages, yet continues, and, no matter what the future of silver may be, will doubtless always be more of a custom than it has been in the past.

Naturally the decline in the price of silver forced men to an effort to find gold. Though Colorado was founded upon gold mining, and though for several years no other mining was carried on, the gold resources were considered so much inferior to the silver resources that they were largely neglected. The few parts of the State (confined

mainly to a portion of five counties) whose principal source of wealth was gold mining were slowly declining, and were certainly not gaining, if they were not losing, in population. Out of twenty counties which can be classed as mining counties, fifteen whose principal source of wealth had been silver mining were constantly gaining in assessable property and population. Thus silver mining became the basis of the State's prosperity. Agriculture, manufacturing, commerce, and transportation depended almost wholly upon these silver-mining regions, which furnished the market for products and by far the greater part of the business for more than 2000 miles of railways. The present condition shows a change to the other extreme. All the attention of prospectors, capitalists, and investors appears to be directed to the gold-producing regions.

The men who lost heart and courage after the "silver smash," as it is commonly called there, were not the old-time, or skilled, miners. The latter generally turned their attention to gold production. Most of them, for want of capital, were forced to seek the golden grains in creek bars and beds, where the appliances were a pan, rocker, or long tom. In this way they could wash out in many places enough to furnish the barest necessities of life, and this, to the real miner, is always far preferable to seeking charity. At one time, in the autumn of 1893, there were at least three hundred men washing gold with pans or rockers within sight of Denver, making probably an average of 50 cents each per day. On this beautiful and mild 24th day of February, 1895, there are a dozen or more men washing gold in pans within the city limits of Denver, and making enough to buy bread and meat by so doing. By far the greater part, however, of the miners and prospectors who were forced into want in July, 1893, have directed their attention to prospecting in other parts of the State, where, if the reward for labor may be less and the certainty nothing, they can hope for better returns. Some of them have been very successful. The inevitable result is the widening of the proven profitable gold-producing part of the State, and an addition to the number of gold-producing properties.

The United States mint report gives the value of the product of gold in Colorado in 1893 at $7,487,071, and in 1894 at $10,616,463,—a gain of 41 per cent. Should the gain for 1895 over 1894 be at the same ratio, the product for the present year will equal $15,000,000. I think it is safe to place it at that amount.

Whether the gold resources of the State are sufficient to warrant a belief in a corresponding increase of 41 per cent. per annum for any considerable number of years is an interesting question. Of course no one can say that such an increase is probable for two, three, or any

other number of years. It may be for two years, but he would be a rash man who would predict any probability of such a thing for any longer period.

But it is certain that, in the wild scramble for silver mines which have existed for a dozen or more years, the gold wealth of Colorado has been overlooked. In the search for the great prizes of silver ore the modest rock which carries from $5.00 to $10.00 per ton in gold has been neglected. The public have only lately begun to see that there is a good deal of profit to be made out of the despised low-grade gold-bearing rock, as well as that the geological conditions throughout the State, as a whole, are more favorable to gold existence than has been supposed by any except the geologists and engineers who have given the subject attention. But, while the latter have often predicted what is now seen, the tangible results of their cautious teachings have been slow in appearing. The discoveries of mines are not usually made by geologists, but by prospectors, and the latter are the most notoriously bigoted men in regard to theories that can be found. For almost thirty years in Colorado, at least, they have, as a rule, been wedded to the idea that gold could not and would not be found in lodes, in paying quantities, except where the lodes exist in granitic or eruptive rocks. Now they are learning that this is not so, and the results of the lesson will be seen in the increased production of gold in the west. The old, granitic gold-bearing regions are all well known, and to some extent have all been prospected. They naturally will increase their product, year by year, for some time to come, because more attention is being constantly given to their development. But the great increase, if there is to be any, cannot be expected from these regions. In fact, within a comparatively short time they must show a decrease, because the life of a mine, like that of an individual, can not go on forever. A ton of ore extracted can never be replaced, and the time is rapidly coming when the world must rely for its gold and silver supply upon new discoveries. The question then becomes one of the probabilities of such discoveries.

The gold-producing regions of Colorado, where that metal constituted the greatest portion of the value produced, was confined to about 500 square miles, all in five counties. Gold was produced to some extent in every mining county, but outside of these regions it was associated with silver in ore, and formed but a small part of the value.

The Leadville "gold belt" has done more to awaken attention to the probabilities of finding gold-bearing rock outside of veins in granitic rock than any other one thing. By the "gold-belt" is meant the country surrounding Leadville in which gold-bearing ore is found on the same geological horizon in which it is found in that

great mining camp. That horizon belongs to paleozoic time, in the lower silurian rocks. The lesson, in its narrow and generally understood limits, is that where these rocks can be found, cut by porphyritic dykes and broken by dynamic disturbances, good ore in some quantity exists. This much appears to be certain,—that the best deposits of ore, both gold and silver, are found where the country is most broken and shattered by dynamic forces, and where porphyry dykes are most abundant. The word porphyry is used in a generic instead of a specific sense. Porphyry has become, by common usage, the name applied to all eruptive rocks. Narrowing the observation, gold appears as though gold is found most abundantly associated with the acid rather than the basic porphyries. Narrowing it still further, gold appears to be found more plentifully associated with those porphyritic rocks in which soda, rather than potash, forms the alkaline composition. This, in the present stage of knowledge about gold occurrence, appears to be the situation.

Speaking generally, it can be said that Colorado has about 8000 square miles in which the geological conditions are favorable to the discovery of gold-bearing ore in paying quantities. That many places like Leadville and Cripple Creek (the productive portions of which did not cover more than 20 square miles) can be found, no one can predict. All one can say is that in these regions scarcely more than one per cent. of the country has been well prospected. But, while there may not be another Leadville or Cripple Creek, there are surely other productive mines, the discovery of which would add greatly to the aggregate of the value produced. What is said about Colorado's possibilities for gold production is probably true, to a less extent, about all the mountain mining country. Certainly there is every reason to believe that all the rich things have not been found. Though the clouds may not have a silver lining, they have a golden tinge, and this is giving a growing ruddy glow of hope to the far west. Hope is always a strong element in prosperity, as it is in happiness. It may be that "the crown of the continent" has been a golden crown, plated with silver, and that the fact is just being discovered. At any rate, so long as gold is the trump, the mining States will hold the best hand.

THE BURNING OF TESLA'S LABORATORY.

By Thomas Commerford Martin.

OF Tycho Brahe's famous observatory at Uraniburg remain to-day but a mound of earth and a couple of holes. The same inventory would aptly apply to all that is left of the upper floor where Nikola Tesla has of late years been carrying on his suggestive and beautiful demonstrations in electricity. Two tottering brick walls and the yawning jaws of a sombre cavity aswim with black water and oil were all that could be seen on the morning of March 13 of a laboratory which to all who had visited it was one of the most interesting spots on earth. Beset by the squalor and clamor of plebeian South Fifth Avenue, the building was unpretentious, and its lower stories were given up to the prosaic details of an iron-pipe cutting business. Commonplace also was the origin of the disaster. A flaring gas jet, oil-soaked floors, and a "watchman" have been heard of before as an effective combination for midnight fires.

It has been curiously pathetic to note how universal was the expression of sympathy with Mr. Tesla in his loss. The newspaper dealers in the marvelous had been so relentlessly active in attempting to describe what they imagined to be going on in the laboratory that they experienced no difficulty in arousing regret as to the magnitude of the loss. But even now, if the average citizen were asked to explain definitely what he was grieving about, he would hesitate to answer. Impressions as to the laboratory have been mixed and weird. For example, one vivid young lady of the press, in her anxiety to be instructive, went so far as to depict herself undergoing a brilliant electrical ordeal that is possible only with the body entirely naked. This grotesque kind of misrepresentation has had vastly more terrors for Mr. Tesla than even the grim episode of last month. Nothing is so absurd as to suppose that inventors of his stamp relish the derogatory *persiflage* of the highly-colored articles that purport to reveal them and their work to the lay public. On the contrary, if it were not all so puerile, it would agonize men striving simply after scientific results and appreciative solely of scientific approval thus to be depicted in the *rôle* of charlatans,—that of a

> Katerfelto, with his hair on end,
> At his own wonders wondering for his bread.

Happily, the Tesla laboratory was visited not alone by irresponsible purveyors of popular misinformation, eager for a new topic to be handled with exhaustive inaccuracy. Happily, the selfish lion-hunters

of society have not been the only other class to which Mr. Tesla had an opportunity of presenting, with his unwearied good nature, new theories, new phenomena, and new apparatus. Happily, before the copper, glass, and insulation melted, physicists, electricians, and representative men in art and literature were able to see and judge for themselves what was forward. Indeed the pressure to secure an *entrée* to the laboratory had of recent months been extreme; and, now that the fire has occurred, perhaps it is as well that Mr. Tesla's imperative refusals once and again had their edges turned. The occasions are certainly rare when an inventor draws general notice to himself; and this is natural, for inventions deal chiefly with outward, material things. A poet or an artist can enter by his work into the life-blood of a people, and becomes part of their soul and growth. An ordinary inventor is more often like a man cutting his initials high up in the young bark of a sapling. The stem rises and expands, but the notches harden and stay ever at the same height, and are foreign to the tree's vital processes. At rare intervals the public becomes dimly conscious of new inventions that touch the arteries of social being; and then it is vaguely, but deeply, stirred. These inventions are generically such as affect and change our methods of obtaining light, heat, and power, our modes of travel, and the transmission of intelligence. The public had learned, more by intuition than knowledge, that Mr. Tesla was at work in each of these fields.

The Tesla laboratory was, in a sense, a private museum. The owner kept in it many souvenirs of bygone toil and experiment, and an important part of his records. During the past ten years Mr. Tesla has done an enormous amount of original experimentation, and it was all represented in the contents of the laboratory. His priority and preeminence in the polyphase current domain, which has been created by the development of his principle of the "rotating field," was richly exemplified by models and parts of single, two, three, and multiphase motors of all kinds. Some of the pieces showed how careful of his material the inventor always was. A close observer could discern that he had used it sometimes a dozen ways in a dozen forms. Readers of the ENGINEERING MAGAZINE may remember to have seen these relics in Electricity Building at the World's Fair, as well as the curious ring wound for two-phase circuits over a smooth disc upon which copper balls revolved at wild speed, or near which other bodies could be set spinning rapidly. This illustrated graphically the manner in which Mr. Tesla was able in his motors to dispense with commutators and brushes. Another notable class of apparatus in the laboratory was that employed for researches into the qualities and effects of currents of high potential and high frequency. Mr. Tesla's name is peculiarly asso-

ciated with this work, and his too infrequent lectures have described a wide range of results obtained in lighting novel electric lamps, or empty bulbs, in free space, without any connection with the distant wires or machinery. In this group may be included his early dynamos for generating high-frequency currents, one of them giving as high as thirty thousand alternations per second; and of equal interest were the disruptive discharge coils designed and built specially to demonstrate a number of recondite and startling discharge phenomena. There were also several unique appliances with which novel conditions could be studied in insulation, induction, impedance, and resonance.

But that which was of largest interest to everybody was the group of oscillators. In the new machine to which he gave quite appropriately the name of "oscillator," Mr. Tesla had blended or merged the dynamo and steam engine, seeking thereby to secure a far higher efficiency than both could give individually at their best. It is curiously typical of the man that he had no sooner placed in the hands of electricians the means for the economical long-distance transmission of water powers—his system being adopted widely, for example, at Niagara—than he threw himself on the problems of getting electrical current more cheaply from steam; and that, while lavishly generous in personal intercourse, he is ever fighting savagely the waste that goes on in our utilization of Nature's resources. It is something to have rendered the waterfalls more useful, but one's sympathies must equally go out to work that is aimed at greater economy of coal. If each 10 hours' work of 1 h. p. from a steam engine requires a total of 6 tons of coal every year, and if that is subject to further tremendous losses when turned into electric current, it is worth the effort to aim at less wasteful processes. This is the goal of Mr. Tesla's oscillator, and he is sanguine enough to believe that he has reached it.

The oscillator is simply a steam chest dissociated from all the orthodox governing mechanism, and joined in a new partnership with sets of electro-magnetic coils, into whose fields of force it thrusts reciprocatively armatures carried by its pistons, the regulation being subtly accomplished by the currents that are thus set up. The reduction in bulk is very striking, but obvious; while the reduction in steam consumption and the higher value of the currents are both elements that Mr. Tesla believes he has insured to a significant degree. He makes few mistakes.

Only one oscillator had ever been shown in public,—that, namely, which Mr. Tesla used in his lecture before the Electrical Congress at Chicago, in August, 1893, employing compressed air as the working fluid, for convenience. That machine and later types were all to be seen at the laboratory. The most advanced form shown to visitors

was a very neat mechanism, entirely practical and successful, by means of which the laboratory had been lighted for months as well as furnished with current for the work done with the high-frequency apparatus alluded to above. It was run at 350 lbs. steam pressure; but, although there was no packing, no leakage of steam could be detected. Two pistons vibrated in opposite phase eighty times per second. The vibrations of these pistons past two sets of electromagnets developed current that was led to a bank of fifty or sixty incandescent lamps, which were lighted up to full candle-power and were steadiness itself in illumination. Current was also furnished by the machine to four arc lamps and to motors, as well as to devices of a fascinating nature, by means of which Mr. Tesla would light up tubes or ordinary incandescent lamps in the centre of the laboratory,—a room perhaps 40 feet by 80. He also used the current to experiment boldly with the electrical charge of the earth itself. One cannot but regret that all these first fruits of penetrative investigation have gone down in the wreck at South Fifth Avenue. They are being swiftly reproduced by incessant labor on the part of the dauntless inventor, but as the first, and, for awhile, the only exemplars of their kind, they are now touched with a sentimental interest unworthy neither of those who feel it or of the objects themselves.

Perhaps the most painful loss of all is the destruction of Mr. Tesla's notes and papers. His memory is all right, and flashes on any experiment of the past with the revealing power of a search-light; but when can leisure now be won to jot things down that, marking achievement on one hand, might also save other experimenters years of toil, and that would show to capital as well the doors open as the paths that are blind. The loss falls least heavily on the loser. Like many another tireless experimenter, he hoped to give the world with due rapidity the report of his failures as well as of his discoveries, but he had not counted on casual destruction of memorabilia by fire as one of the obstacles in his way. Mr. Tesla had taken the papers to his laboratory so that he might work on them in brief leisure spells, and was thus the victim of his own conscientious endeavor to be of use to his fellow-electricians. There seems to be a fate about such things. Galileo's own son, from filial religious motives, destroyed some of his father's dearest manuscripts; and it was no less a friend than John Stuart Mill who burnt up for poor Carlyle the first volume of the unprinted "French Revolution." It took Carlyle four weeks, and heaps of the trashiest novels, to quiet his mind after the miserable accident. Tesla was at work again with clenched determination while the ashes of his hopes lay hot.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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A .....Arena. *m.*. $5. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Arch. Build. and Dec. *m.* $2. Minneapolis.
A C J ..Am. Chem. Journal. *b-m.* $4. Baltimore.
A E C U..Asso of Eng. of Cornell Univ. 1894. Ithaca.
A E R J.Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A J S ...Am. Jour. of Science. *m.* $6. New Haven.
A L ....The Architect. *w.* 26*s.* London.
A M ....American Machinist. *w.* $3. New York.
A M C...Amer. Mag. of Civics. *m.* $3. New York.
Am M ..American Miller. *m.* $2. Chicago.
Am S ...American Shipbuilder. *w.* $2. N. Y.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S ...Age of Steel. *w.* $3. St. Louis.
A S I E .Amer. Soc. of Irri. Eng. *qr.* $4 Denver.
A S M E.Am. Soc. of Mec. Eng. *m.* New York.
B.....The Builder. *w.* 26*s.* London.
B A... .The British Architect. *w.* 23*s.* 8*d.* London.
B B.....Brick Builder. *m.* $2.50. Boston.
B G S....Bul. Am. Geog. Soc. *q.* $5. N. Y.
B I S . ..Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B M ....Banker's Mag. *m.* 18*s.* London,
B M A...Bankers Mag. of Australia. *m.* $3. Melbourne.
B T J ...Board of Trade Journal. *m.* 6*s.* London.
B U W...Bul. of the Univ. of Wisconsin.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A.. Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C Eng....Canadian Engineer. *m.* $1. Montreal.
C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
C M R...Canadian Mining Rev. *m.* $1.50. Ottawa.
Com ....Commerce. *w.* 36*s.* London.
Cos.... ..Cosmopolitan. *m.* $1.50. New York.
C R.....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D E.....Domestic Engineering. *m.* $2. Chicago.
E.....Engineering. *w.* 38*s.* London.
E A.....Electrical Age. *w.* $3. New York.

E & C....Engineering & Contractor *w.* $1. San Francisco.
E A S....Eng. Asso of the South. *m.* $3. Nashville.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E L....Electrical Engineer. *w.* 19*s.* 6*d.* London.
E E N Y..Electrical Engineer. *w.* $3. New York.
E G.....Engineers' Gazette. *m.* 8*s.* London.
E I.....Electrical Industries. *m.* $1. Chicago.
E L.....Electricity. *w.* 7*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng.....Engineer. *s-m.* $2.50. New York.
EngL... Engineer. *w.* 36*s.* London.
E N Y....Electricity. *w.* $2.50. New York.
E P .....Electrical Plant. *m.* 6*s.* London.
E R.....Engineering Record. *w.* $5. New York.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F.....Forum. *m.* $3. New York.
F D.....The Foundry. *m.* $1. Detroit.
F R.....Fortnightly Review. *m.* $4.50. London.
F W.....Fire and Water. *w.* $3. New York.
F'y.....Fairplay. *w.* 32*s.* 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G & F....Garden and Forest. *w.* $4. New York.
G M.....The Geol. Mag. *m.* 18*s.* London.
G R.....Good Roads. *m.* $1. New York.
G W.....Gas World. *w.* 13*s.* London.
H & V...Heating and Ventilation. *m.* $1. N. Y.
I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I E.....Indian Engineering. *w.* 18 Rs. Calcutta
I Eng....Indian Engineer. *w.* 20 Rs. Calcutta.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25*s.* Lond
I C B.....Carpenter and Builder. *w.* 8*s.* 8*d.* London.
I C T.....Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv.....Invention. *w.* 11*s.* London.
Ir Age..Iron Age. *w.* $4.50. New York.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J G L.....Journal of Gas Lighting. *w.* London.
J N E W..Jour. N. E Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J S A.....Journal of the So. of Arts. *w.* London.
L A.....The Landscape Architect. *m.* $1.50. Rochester.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L. H. P..Light, Heat and Power. *m.* $3. Phila.
M.....Machinery. *m.* 9*s.* London.
M A. ..Machinery. *m.* 50 cts. N. Y.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* London.
Met W...Metal Worker. *w.* $2. N. Y.
Mill.....Milling. *m.* $2. Chicago.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
Min W..The Mining World. *w.* 21*s.* London
M J.....The Mining Jour. *w.* £1. 8*s.* London.
Mo ...The Monist. *qr.* $2. Chicago.
M R .....Manufacturer's Record. *w.* $4. Baltimore
M S F....Master Steam Fitter. *m.* $1. Chicago.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C.....Nineteenth Century. *m.* $4.50 London
N C B...National Car Builder. *m.* $2. New York.
N S R....The New science Review. *qr.* $2. N. Y.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
P.....Paving. & Mun. Eng. *m.* $2. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P E C P. Proced. Engineer's Club. *q.* $2. Phila.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D .....Plumber and Decor. *m.* 6*s.* 6*d.* London.
Pr.....Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J...Railroad Car Journal. *m.* $1 New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York
R P L....The Railway Press. *m.* 7*s.* London.
R R.....Railway Review. *w.* $4. Chicago
R W.....Railway World. *m.* 5*s.* London
Ry T.. . The Railway Times. £1. 5*s.* London.
S..... .....Stone. *m.* $2. Chicago.
S A.....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn
Sc..... ...Science. *w.* $5. Lancaster, Pa.
Sc A ....Scientific American. *w.* $3. New York.
Sc A S...Scientific Am. Supplement. *w* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Col
S E.....Stationary Engineer. *m.* $1. Chicago.
S Ec ....Social Economist. *m.* $1.50, N. Y.
Sea.....Seaboard. *w.* $2. New York.
S In.....Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L.....Steamship. *m* Leith, Scotland.
S M.....Scientific Machinist. *s-m.* $1.50. Cleveland, O.
S M Q....School of Mines Quarterly. $2. N. Y.
S R.....Sanitary Record. *m.* 10*s.* London.
S R E N..St. R'y. Elec News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $2. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R...Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1. New York.
T.....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E. Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E... Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
Tr.....Transport. *w.* £1. 5*s.* London.
Tr A M E. Trans. Am. Ins. of Mining Eng. N. Y.
T W A...Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E.....Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London

ARCHITECTURE & BUILDING

About Chimneys.

CHIMNEYS constitute an architectural and constructive problem, often not the least difficult of those which are encountered in the designing of new buildings. Were the points to be considered those pertaining only to artistic treatment, the subject would not be so difficult to deal with. The chimney, or chimneys, in such a case could be placed in the design where the best artistic effect demands, and the height above the roof could be adjusted to accord with the taste of the designer. But, as the chimney is a working device, its function being to pass a current of gases from the interior to the exterior of the building, regard must be paid to this function, and the location, size of flue, and height above roof must be considered with reference to that function. The same may be said regarding ventilating flues.

Mr. Fred. T. Hodson, in *Architecture and Building*, discusses the question at length, beginning with a historical sketch of the introduction of this feature of modern architecture, which he places near the beginning of the twelfth century, the first example known to history being in Rochester Castle, about the year 1130. In this building, also, as far as can be discovered, the first open fireplaces were used. "Italy claims that chimneys and fireplaces originated with her, though she has no tangible evidence to exhibit in proof of her claim; while in England many examples exist, dating from the twelfth century,—one, that in the great guard-room at Curisborough Castle, dating back as far as the early part of the eleventh century, bearing on its face evidences of having been erected during the Anglo Saxon period; yet this fireplace has no chimney such as we know. In place of a chimney there is a flue or duct leading to the outside of the wall some twenty-five or thirty feet above the top of the fireplace. Doubtless it was this sort of a flue that led to the construction of the chimney as we now possess it, the flues being built in the walls, the thickness of which was ample to admit of pretty large ones. At first these flues terminated on the top of the wall and were topped off with hoods, arches, cowls, and other devices; but it was not long before medieval builders carried the flue a considerable distance above the walls. Then the architect's opportunity arrived, and he at once accentuated the projection, and made it an ornamental feature of the building to which it belonged; and to-day most of our best forms of chimneys are copies taken from the works of those old designers." In the United States the artistic treatment of chimneys has not received the attention given to this feature abroad, but of late years many fine examples of chimney architecture have been designed.

"The philosophy involved in the operation of a chimney depends altogether on the principle that a column of heated air is lighter than a cooler column of like dimensions. This being admitted, it follows that the lighter air will be forced upward by the heavier, just as a body lighter than water will be forced to the surface by the action of the heavier body. It is this action, caused by the difference of density, that establishes a current of draught. All other conditions being equal, the draught of a chimney is thus proportioned to its perpendicular height, and, of course, the difference in temperature within and without the flue. The straighter and taller the shaft, the more powerful will be the ascending current: but there are cases, no matter how straight or how lofty the chimney may be, that will refuse to conduct the smoke through its length under certain mysterious conditions. Some causes of chimneys smoking are well known and avoidable, the trouble arising perhaps from positive ill-construction having a narrow part, an ugly bend, or a downward portion in their conduit, which their normal draught is not sufficient to over-

come. Others smoke because they form the shortest channel by which the air can enter the house to supply the draught of a higher chimney. When there are two chimneys in one room, or in rooms adjacent to each other, and the doors and windows are closed in all other rooms, the shorter chimney will draught inwardly to supply the loftier one with a current. Sometimes the best constructed and most wisely designed chimney, with regard to the building in which it is situated, will smoke in consequence of its exit being in the immediate neighborhood of walls, hills, or trees, whose situation is such as to create at times strong eddies and cross-currents. In most cases, however, the addition of a few feet or so to the height of the chimney shaft, supposing it to be already above the ridge of the house which it ventilates, will prove more useful than any addition of those curiously contorted and usually non-pneumatic contrivances that are so often planted on the top of a smoky chimney to cure it of its 'cussedness.'"

Count Rumford is recalled as perhaps the chief of all chimney doctors. It is on record that he cured more than five hundred smoky chimneys where all previous attempts had failed. His system was to diligently search for, and remove, the local causes that obstruct draught, as he held that the very fact that the draught is defective is proof of the existence of such a cause either in the chimney itself, or in its immediate environment.

The design and construction of a factory chimney "require more architectural skill and scientific knowledge than most practitioners can lay claim to." As an assistance to designers, formulæ, and a table based upon these formulæ, are given, and practical questions, such as expansion, etc., are discussed, as are also care and inspection of chimneys.

Wind-Pressure on Buildings.

IN the department of "Civil Engineering" in our February number, the subjects of tornadoes and wind-pressure exerted upon bridges and other structures were noticed, and the current technical literature of the month shows that the effect of wind-pressure is still claiming further and closer study. The London *Builder* has a leading editorial in its issue of February 2, which deals more particularly with the reduction of pressure on the leeward side of buildings as an element not included in time-honored formulæ, whose results are now regarded with more than suspicion in view of facts of comparatively recent occurrence. The first who called attention to the fact of reduction of pressure on the leeward side of structures subjected to the action of winds is said to have been Mr. Horatio Phillips, an experimenter whose work in this direction, the *Builder* thinks, has not received the recognition it deserves. "Since then, other investigators have pursued the subject. The latest addition to our knowledge on this question has been supplied by a Swedish experimenter, Mr. R. Irminger, who has recorded the results of his investigations in the form of a paper published in the *Ingenioren* of Copenhagen, and a translation of which may be found in the Library of the Institution of Civil Engineers. The experiments were made with models, and, though some correction might be necessary in applying the results to larger planes, yet the results clearly indicate that the question of wind on roofs requires reconsideration."

Mr. Irminger's method is substantially the same as that of Mr. Phillips, except in the manner of obtaining induced currents. Mr. Phillips used steam jets for this purpose. "Mr. Irminger has recourse to an opening in a tall chimney. In this was inserted a horizontal wooden tube 9 in. by 4½ in. in section. Experiments were made with inclined planes, spheres, cylinders, pyramids, and cones. The planes were each represented by two thick iron sheets placed one-tenth of an inch apart, and their edges connected all round, thus forming a shallow closed box. Holes were bored on both surfaces, and these could be plugged at will. The pivot on which the plane swung was a pipe leading to the interior of the box and having a pressure-gage on the end. In this way increase or reduction of pressure on either surface of the box-like plane could be ascertained. A plane 4½ in. by 1½ in. and

occupying the full width of the tube was tried at various angles of inclination and with four velocities of air. When the plane was at an inclination of 5 degrees to the direction of the wind, the percentage of the total pressure which was produced on the leeward side of the plane was 100 at all velocities of wind tried, and the total wind-pressure was 23 per cent. of what it would have been had the plane been normal to the air current. By "pressure on the leeward side of the plane" is meant the pressure on the leeward sheet of iron. This pressure would naturally be in the direction of the wind, and would be caused by the reduction of atmospheric pressure on the opposite side, due to rarefaction. At an inclination of 10 degrees, with an air velocity of 49.5 ft. per second, the proportion of total pressure on the leeward side was 82 per cent., and at 31 ft. per second the pressure on the leeward side was 91 per cent. The proportion of total wind-pressure at this angle, as compared to the same area of normal plane, was 45 per cent. At 40 degrees inclination of the plane, and with a velocity of 49.5 ft. per second, 65 per cent. of the total pressure was due to the leeward side; at 31 ft. per second it was 70 per cent. The proportion of pressure as compared to the normal plane was 35 per cent. at this angle. At 90 degrees inclination of the plane, and 49.5 ft. per second of air current, the proportion of total wind-pressure due to the leeward side was 56 per cent.; at 31 ft. it was 59 per cent., and at this angle the total pressure was equal to that which would have been sustained had the plane been vertical or normal to the current. We have, for the sake of brevity, selected only a few typical instances contained in Mr. Irminger's tables, and the figures as to the proportion of pressure as compared to normal planes are averages of a larger number of experiments than we quote. The plane referred to, having its ends touching the sides of the box, may be considered as a plane of infinite length. Mr. Irminger tried a similar series of experiments with a plane 2 in. shorter,—viz., 2½ in. by ½ in. At 5 degrees inclination the results were very similar to those obtained with the larger plane at the same inclination, excepting that the proportion of total pressure as compared to the normal plane was but 12 per cent. At 10 degrees inclination also the whole of the total pressure was due to the leeward side, but the pressure was 26 per cent. of that due to a normal plane. At 40 degrees inclination and 49.5 ft. per second of air current, the proportion of total pressure due to the leeward side was 78 per cent.; at 31 ft. per second it was 74 per cent., and the proportion of total pressure compared to the normal was 74 per cent. At 90 degrees inclination, it was 49.5 per cent. of the whole; at 31 ft. per second it was 40 per cent. of the whole. The total pressure at this angle, as with the other plane, was equal to that of a normal plane."

Probably some will object to these experiments that the conditions under which the results were obtained by Mr. Irminger are not yet demonstrably the same as those under which buildings are subjected to strains in gales of wind; but, even admitting the validity of this objection, the experiments clearly prove that a change of pressure-conditions does occur on the leeward side of the plane when a current of air impinges against the opposite side, and also that the reduction is a notable percentage of the force with which the wind acts on a resisting or a deflecting surface.

The experiments were extended to cubes and prisms. A cube with the wind striking it parallel to the edge showed a total resultant pressure in the direction of the wind of 0.80 of total pressure on a disk equal to the face, the percentage due to rarefaction being 22 per cent.; with the wind parallel to the diagonal of the face, the pressure was 0.66. A cylinder of a height equal to its diameter received a pressure of 0.47 of that which would have been exerted on a square disk equal to a section through the axis, the rarefaction ratio being 50. A pyramid of square base, with a side equal to the height, gave, with the wind parallel to the side of the base, a pressure of 0.78 of that which would have been exerted upon a disk equal to a maximum section perpendicular to the wind; with the wind diagonal to the base, the

corresponding percentage was 55. In the former instance the rarefaction was 37 per cent. Lastly, with a cone in which the height equalled the diameter of the base, the resultant pressure was 0.38 of that due to a disk equal to the maximum section perpendicular to the wind, 50 per cent. of the total pressure being due to rarefaction.

Experiments with analogous results were also made with models representing buildings of different forms. Some of the effects upon roofs are peculiar; for instance, with a roof of 45 degrees pitch, the wind blowing at right angles, the part on the lee side was subjected to an upward resultant pressure of more than three times the "actual wind pressure on the windward side," and on the windward side the pressure diminished uniformly from the lower edge to the ridge, where it became *nil*. Now, these experiments indicate either that the experiments themselves are unreliable, or that there are mysteries in the action of winds that challenge immediate and thorough investigation by a number of experimenters sufficient to clear up all remaining doubts upon the subject.

Velocity and Pressure of Wind.

THE above remarks may be fitly followed by a review of some notes on the effects of wind upon structures in Quebec during the storm that visited that city December 28, given in *The Canadian Engineer* for February by Mr. Charles Baillairge. Several chimneys 80 to 120 ft. high were blown down, and the roof of the westernmost kiosk of Dufferin Terrace "was bodily wrenched from its understructure of cast-iron columns, girders, supporting brackets, spandril pieces, etc., and blown to a distance of 100 ft. or more and half way up the cliff intervening between the terrace, which is at 180 ft. above river level, and the citadel at about double that elevation." What this latter feat really signifies is well brought out by a calculation made by Mr. Baillairge, who estimates the weight of the roof, in detail, "at some 2½ tons, including cast-iron rafters, iron purlins, galvanized sheet-iron covering, wrought-iron tie-rods, and the like. Taking the resistance of ordinary bar iron at only 25,000 lbs. to the sq. in., or 12½ tons, and, as the roof was held in place by light wrought-iron screw bolts and nuts of ⅝ inch diameter, to break each of which a strain of 3⅛ tons must have been exerted together, including weight of roof (some 27½ tons), the area acted on by the wind being say 640 ft., the conclusion is arrived at that a force of not less than 86 lbs. must have been brought to bear per sq. ft. of area to produce the effect recorded; and, if the pressure be assumed to increase as the square of the velocity, this velocity at that particular point or portion of the terrace must have been 130 miles an hour."

The anemometer at the Quebec Observatory is said to have broken down after recording a velocity of 90 miles per hour, but the wind evidently increased in velocity after the anemometer ceased to register. Mr. Baillairge expresses the view that, "while the general velocity of the wind may not have exceeded from 80 to 100 miles, there may have been within the general current a local one of greater speed, as with the Gulf Stream flowing from the Gulf of Mexico into and across the Atlantic ocean Or the increased velocity and force at that particular point may have been and was likely due to some cyclonic or gyratory action, as often observed in cyclones, such as we have all been witness to when, on a windy day and while the air in motion along a street takes the dust with it and thus becomes visible to the senses, a tiny cyclonic action may be observed here and there, where streams of wind rotate as they advance with the general current in which their motion forward or of translation is involved. Another argument favoring this conclusion is that along the 1,500 ft. of terrace, every portion of which is equally exposed to the fury of the wind, there are four other kiosks of exactly the same construction as the one unroofed by the storm; and, while one of these suffered only to the extent of having a small portion of the roof sheathing torn and blown away, the others stood the fury of the gale unscathed." The tall buildings now standing and going up, if subjected to such

wind-pressures as this, would have their strength tried to a limit that certainly would be ground for anxiety.

Slate and Tile Roofs.

A CONTRIBUTOR to the *Pall Mall Gazette*, quoted in *The Illustrated Carpenter and Builder* (London, Feb. 1), describes the slate and tile roofs in various parts of England. The Cumberland slate is considered as one of the most beautiful roofing materials known, on account of its "exquisite greenish-gray color, with silvery reflections and glaucous bloom. The purple Welsh slates make roofs that, according to this pleasant writer, are simply hideous compared with those of Westmoreland and the older roofing slates, but their great durability is nevertheless bringing them into favor.

"The train has halted at Hawes Junction, and it is evident that the invader has gained a footing even in the heart of the dale. All round for miles, dotted on the grassy slopes, may be seen the grim gray garths and haybarns of the 'statesmen' and farmers, with stone roofs deeply stained with olive and russet and splashed with golden lichen. But the harmony is shattered by spick-and-span railway buildings, smugly hatted with purple Welsh slates; and even in the villages it is plain that the old fashion is falling out of favor, for all the new dwellings and the meeting-houses are roofed with Welsh slate. Time, the great redresser of wrongs and veiler of blemishes, is almost powerless to help matters. The close crystalline texture of these slates enables them to resist all kindly vegetable pigment. It is true that sometimes, near the sea, a salt crust is deposited, giving foothold to an orange lichen, which creeps over the surface with charming effect; but generally the tone remains unchanged, and rarely is a roof now put on with liberal eaves. The worst of it is that there is no remedy, for not only is the new material provokingly excellent for resisting wind and weather, and very clean, but it is ridiculously cheap, and requires much less weight of timber to support it than tiles, stone, or the heavier slate of Cumberland."

The effect is described as even worse in Scotland, where trees are scarce and do not hide the blemish. The Annansdale and Nithsdale village roofs of red sandstone flags that afforded a fine contrast with the gray stone walls are being replaced with the purple Welsh slate, very much derogating from the picturesqueness of Scottish villages. The same is true of tile roofs. "Few people are aware how much tile roofs were in use in Scotland from early times, and how greatly the scenery has suffered from their disuse. Those square border keeps which are such familiar objects in the lowland landscape once had a very different appearance. There is preserved in the British Museum (Cottonian collection, 'Titus,' c. xli, folio 76–87) a report on the military strength of the Western Marches by an English officer in 1563-66. This is illustrated by water-color drawings of the chief strongholds and some of the towns in Dumfriesshire and Galloway. All the castles, except Annan, and all the houses in the towns, are shown with steep red roofs,—that is, roofs of tile. The churches have gray roofs of stone, and the tower of Annan has a blue roof, apparently meant for lead. Now, it may seem a small matter to complain of, that, in a few years, English villages and Highland shielings will be uniformly sheeted with changeless mauve slate, and the complaint, as has been admitted, is a futile moan. But would the injury be reckoned a light one if some day the eye of one standing on the roof of the Duomo of Milan were to rest, not, as now, on countless housetops of heavy red tiles, but on an unbroken expanse of smooth metallic purple?"

Weathering of Building Stones.

A PAPER upon this subject, read by Prof. Coleman, of the School of Practical Science, Toronto, before the Ontario Association of Architects at its fifth annual convention, and printed in the *Canadian Architect and Builder*, contains points relating to the effects of atmospheric influences upon building stone that will be new to most lay readers. The expansion of stone near the surface when the sun shines

strongly upon it in cold weather is one of the agencies by which destruction is gradually brought about. Stone being a poor conductor of heat, a thin stratum on the outside is expanded by solar heat before the inside is heated, and strains are thus generated which tend to cause scaling of the surface, or, perhaps more accurately, prepare the stone for the more powerful action of frost. The minute pressures caused by expansion admit water. This, subsequently freezing, expands with great force, and thus portions of the stone are flaked off. Another effect of temperature is the contraction in cold weather of mortar joints that have been laid in warm weather. This tends to produce fissures that "admit water and make the starting-point for other changes. As a general rule, stone absorbing 10 per cent. crumbles rapidly in our (Canada) winters, and should not be employed where carving or fine finish of any kind is exposed to the weather."

As to the chemical action to which stone is subjected in different climates, Prof. Coleman says: "Rain water is more or less strongly charged with oxygen, carbonic acid, and other substances found in the air. The nitrogen of the air is inert, and the oxygen and other substances are active only in the presence of water, so that very dry air has little or no effect in weathering. In very dry climates, like that of Egypt, monuments of stone may be ground off by driving desert-sand acting as a sand-blast, but are scarcely affected in other respects after 4000 or 6000 years' exposure to the weather. How differently a damp climate affects the stone may be seen only too well in the Egyptian obelisks transported to London, Paris, and New York. It is well known that in the last-named city the granite scaled so rapidly that the obelisk had to be coated with paraffine to preserve it at all."

There is, however, one chemical change that stone undergoes which is welcomed by architects and all lovers of the beautiful and picturesque. This is the change of color produced chiefly by low oxidation: "This may be called the mellowing touch of time as contrasted with the gnawing tooth, and from the artistic side an architect's work, like a rich wine, may ripen and improve with years. On the other hand, there are color changes produced by other reagents than oxygen,—notably sulphur—that may greatly disfigure buildings. Certain sulphids, especially the brassy yellow mineral pyrites, are changed by oxygen in the presence of moisture into sulphates, and finally into oxids. Granites, marbles, and other crystalline rocks are stained an ugly brown by the hydrous oxid formed, so as to be quite disfigured. This change is less important in the sandstones, though even then the change of color may be disagreeable. Many stones used in the Parliament Building at Ottawa illustrate this, the dark brown smear having sometimes run down onto the blocks below. Stones rich in magnetite, such as diabase, sometimes used as black granite, may be acted on in a different way. The mineral magnetite consists of the sesquioxid of iron combined with the monoxid. The latter portion may weather into hydrous sesquioxid, giving brown stains, and sometimes causing the rock to crumble. The color schemes of buildings should always be considered with reference to the changes which atmospheric influences will effect, and also with reference to the custom prevailing in the environment, in the matter of the use of fuel,—hard or soft coal, etc.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29148. Recent Architecture in France. Ill. Barr Ferree (E Mag-April.) 4000 w.

†29154. Padauk. Editorial (I Eng-Jan. 5.) 1500 w.

29184. Church of All Saints, God's Hill. Ill. (A A-Feb. 9.) 3000 w.

*29188. E. G. Paley's Churches. Ill. (A L-Feb. 1.) 2700 w.

*29199. Wind Pressure on Buildings—Experiments of R. Irminger (B-Feb. 2.) 1800 w.

*29201. The Legal Position of Architects in Relation to Certificates and Awards. J. A. Strahan, with Discussion (B-Feb. 2.) 6000 w.

*29202. Tynemouth Priory. Ill. E. R. T. (B-Feb 2.) 2400 w.

We supply copies of these articles. See introductory.

*29211. Styleless Architecture. Anon. (A B D-Dec.) 2000 w.

*29237. Faults in Outside Painting. A. Ashmun Kelly (I C B-Feb. 1.) 700 w.

*29238. Slate and Tile Roofs. Anon. (I C B-Feb. 1.) 1200 w.

*29240. American Mantels. Ill. Anon. (I C B-Feb 1.) 1000 w.

*29242. Building Stone. Anon. (I C B-Feb 1.) 1100 w.

29249. Velocity and Pressure of the Wind—Notes on the Storm of Dec. 28th at Quebec. Charles Baillairge (C Eng-Feb.) 750 w.

*29254. Notes upon Testing Building Stones. F. Lynwood Garrison. Read before Amer. Soc. of Civ. Eng. (S-Feb.) 3500 w.

*29256. The Granites of Scotland. (Extract.) Hjalmar Lundbohm (S-Feb.) 4200 w.

29307. Recent Experiments on Wind Pressure—Abstracted from 'Ingenioeren" by O. J. Marstrand (E N-Feb. 14.) 2200 w.

*29337. Borders and Bands. Ill. H. Leslie Ramsey (Pl D-Feb.) 1200 w.

*29338. A Chat on Mural Decoration. W. N. Brown (Pl D-Feb.) 1000 w.

*29404. Hints for Churches in Hot Climates. Anon. (B-Feb. 9.) 2800 w.

*29406. Architectural Perspective. Ill. W. S. Weatherley, with Discussion (B-Feb. 9.) 8000 w.

*29455. Exigencies of Commercial Buildings—From the Building News (I C B-Feb. 8.) 1300 w.

*29476. Noyon Cathedral. Anon. (A L-Feb. 8.) 1800 w.

29512. Cements. H. F. Bryant (M & B-Nov.) 700 w.

29514. The Influences Against the McKaig Bill. John M. Carrère (A A-Feb. 23.) 2500 w.

29549. Stamp Sand in Cement Mortar. Edward Kidwell (E M J-Feb. 23.) 400 w.

*29580. Shearing Tests of Mortar. Cecil B. Smith (B B-Feb.) 700 w.

*29584. Portland Cement—A Plea for a Greater Uniformity in the Tests and Specifications. C. H. C. Wright (Can A-Feb.) 3000 w.

*29585. Electricity for Architects. John Langton (Can A-Feb.) 3600 w.

*29586. The Weathering of Building Stone. Professor Coleman (Can A-Feb.) 2200 w.

*29604. The History of Architectural Drawing. Anon. (I C B-Feb. 15.) 800 w.

*29605. Isometric Projection. H. A. Caxton Jay and A. Robinson (I C B-Feb. 15.) 900 w.

*29607. The Study of Old Buildings. Anon. (I C B-Feb. 15.) 1100 w.

*29610. The Ancient Cambodian or Khmer Monuments in Eastern Siam. Ill. Anon. (B-Feb. 16.) 3000 w.

29760. A Travelling Scaffold for Painting the Roof of a London Train-Shed. C. H. G. (A A-March 2.) 900 w.

*29845. The Roman Fort at Saalburg. Ill. Anon. (B-Feb. 23.) 2500 w.

29924.—$1.50. The Strength and Weathering Qualities of Roofing Slates. Ill. Mansfield Merriman, with Discussion (T C E-Dec.) 3500 w.

Serials.

12568. Building Construction and Superintendence. F. E. Kidder (A & B-Began May 6, 1893—40 parts to date—15 cts. each).

18857. Electrical Science for Architects. Ill. Russell Robb (A A-Began Jan. 13, 1894—8 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (B B-Began Jan., 1894—14 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (Pl D-Began March, 1894—11 parts to date—30 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B-Began April, 1894—10 parts to date—30 cts. each).

26070. The Planning and Construction of American Theatres. Ill. William H. Birkmire (A & B-Began Oct. 13—5 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (I C B-Began Nov. 9—6 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (A & B-Began Nov. 24—4 parts to date—15 cts. each).

28494. Bricks and Terra Cotta (B-Began Jan. 5—7 parts to date—30 cts. each).

28582. Architecture in India. N. N. Waslekar (I A-Began Jan.—2 parts to date—45 cts. each).

28805. Fireproof Floor Arches. Ill. George Hill (B B-Began Jan.—2 parts to date—30 cts. each).

29200. The Advancement of Architecture. Professor Aitchison (B-Began Feb. 2—4 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (S-Began Feb.—1 part to date—30 cts).

29327. The Use of Steel in Large Buildings. (Abstract.) Corydon T. Purdy. Read before the Boston Soc. of Civ. Eng. (E R-Began Feb. 16—2 parts to date—15 cts. each).

29358. Hints to Art Students in Travelling Abroad. J. W. Case (A A-Began Feb. 16—3 parts to date—15 cts. each).

29578. On the Use of Brick in Domestic Architecture. Ill. Ralph Adams Cram (B B-Began Feb.—1 part to date—30 cts).

29581. Ornamental Brick Arches. Ill. Archie (B B-Began Feb.—1 part to date—30 cts).

29582. On Observation. Leonard Stokes (B A-Began Feb. 15—Ended Feb. 22—2 parts—30 cts. each).

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

Recent Work of the Massachusetts Highway Commission.

"ALL friends of the good-highway agitation in the United States," says *The Engineering Record* (Feb. 23), have been following with much interest the work of the Massachusetts Highway Commission, composed of Mr. George A. Perkins, a lawyer of Boston, Prof. N. S. Shaler, of Harvard University, and Mr. W. E. McClintock, M. Am. Soc. C. E., of the engineering firm of McClintock & Woodfall, Boston.

The method of proceeding followed by city officials or selectmen of towns when they wish to place an old or new road under the charge of the State is to make application to the commission in proper form, and file a plan of the road. "In case the commission believes that the highway should come under the control of the State, it files a plan of it in the office of the commissioners of the county in which the petitioners reside. With this plan is filed a copy of the petition, and a certificate that it has laid out and taken charge of the road. The commission also files a copy of the plan of the portion lying in each city or town with the clerk of the city or town. When this is done, the road becomes a State highway, and the commonwealth is responsible for the construction and maintenance, no openings or obstructions being allowed along its length except with the permission of the commission.

"When ready to begin actual work on the road, the commission gives to each city and town in which the highway lies a certified copy of the plans and specifications. The city or town then has the right, without advertisement, to contract with the commission for building so much of the highway as lies within its limits, the work to be done under the supervision of the commission and subject to its approval. If the local authorities do not care to do this, then, after the lapse of 30 days, the commissioners advertise in at least two papers published in the county where the road is located, and in three or more Boston daily papers, for bids for the construction. The selection of roads for State control is required to be 'fairly apportioned' among the different counties, and not more than 10 miles may be constructed on petition in any 1 year in any one county without the previous written approval of the governor and council. For maintaining the State highways the commission is authorized to contract with the cities and towns in which they lie, or with private parties. One of the unusual features of the act is a clause requiring the commission to keep the roads reasonably clear of brush, to plant shade trees along them, and to establish and maintain watering-troughs at suitable places."

The public jurisdiction of cities and towns over roads thus constructed is stated with its scope and limitations, and the clause of the act providing for cost of construction and repairs follows. The act not having gone into force until June, 1894, it is stated that operations have not advanced as they would have done could work have commenced in the spring. The difficulty of convincing local authorities that they could construct such roads as the act contemplates "was overcome when it was found that a competent man would be stationed on each road where work was in progress, and that the State would make payment at so much per ton for stone, so much per yard for earth and rock excavation, so much for each foot of drain, and at a definite price per unit for all other items. The authorities knew that the State's representative would see that good work was done, and felt that what they accomplished would be accepted. Up to the close of last year thirty-six contracts were accepted, and work was commenced in twenty-seven towns. The construction is carried on under the direction of a chief engineer, Mr. Charles Mills, and a resident

engineer on each piece of work. The resident engineer puts in the line and grade-stakes, and keeps a force account and a record of all work done and material used, making a daily and weekly report to the commission, and a monthly summary of everything accomplished to date. The local authorities are represented by their superintendent of streets, road commissioners, or a competent man appointed as foreman." A copy of the blank forms used in reports, and of the general specifications for the roads, with other general information relating to materials and work, render this an instructive article on road-making.

Anchor-Ice.

THE clogging of gates, wheels, etc., with anchor-ice annually causes serious embarrassment in many parts of the United States and Canada and, indeed, in all cold climates where hydraulic engineering is conducted. Chicago has several times had its water supply thus threatened. At a recent meeting of the American Society of Civil Engineers the subject was brought up for discussion, and remarks offered by various engineers were published in *The Engineering Record* (Feb. 16). The consensus of opinion was that anchor-ice forms through the concreting of minute acicular crystals? Any current tending toward any particular point carries the crystals along. If any solid object be presented to the current against which the crystals impinge, they not only adhere to this object, but immediately stick together, forming a growing mass. This conglomeration of ice-crystals is explained by Tyndall in his famous treatise, "Heat as a Mode of Motion," in the discussion of the phenomenon of regelation. Nearly all who took part in this discussion related interesting experiences with anchor-ice.

Mr. William E. Worthen said he had had a little experience with anchor-ice in the course of his practice. He found that it forms in acicular needles which shoot across the surface of water. If the water is still, the crystals come together to form a solid sheet; but, if there is a ripple on the water, the crystals are broken up, mix with the water in the form of slush, and attach themselves readily to rock, iron, or other material with which they are brought in contact. The same breaking-up of crystals has been noticed with saltpeter in the manufacture of gunpowder. For many years Mr. Worthen lived within a quarter of a mile of the lower falls at Lowell, and he could always tell when anchor-ice was forming. As it formed, the noise of running water ceased, and he found that at such times the weather was sharp and cold, with light breeze.

An account of a large accumulation of anchor-ice on piles driven for the foundation of the Wisconsin river bridge was given by Mr. J. F. O. Rourke. The butts of these piles were covered with ice from top to bottom. The piles being driven in weather 20° below zero, the coldness of the timber was supposed to account for the phenomenon,—an explanation wholly inadequate, we think.

Mr. Desmond Fitzgerald agreed with Mr. Worthen. "If there are winds blowing that keep water in motion, it may not freeze over till the whole body of water is cooled to the freezing-point." This is the condition for formation of anchor-ice, and Mr. Fitzgerald added that at Brookline, Mass., this usually takes place at about Christmas time each year.

Mr. T. C. Reefer said that anchor-ice will run under the frozen ice surface of the St. Lawrence from 10 to 12 miles, and that this is a common occurrence in the St. Lawrence; in fact, at the beginning of winter it [anchor-ice] passes through the whole length of the river before the latter becomes frozen over. He now keeps the run of the temperature of the water, and, if he finds that the whole mass is down to about 32°, while the surface is unfrozen, men are stationed in the gate-houses to watch for anchor-ice. It will form in a very short time after these conditions have been reached. This ice, so far as he has observed, is in the form of needles and thin scales about the size of a half-dollar. It apparently comes in with the current from all parts of the body of water, and has a way of collecting in punky masses which soon fill up all openings. In the

principal gate-house under his charge there is a steam pipe laid, reaching into the water in front of the screens, so that steam can be blown down into the masses of ice to break them up. At the ice bridge, which first forms below Montreal, the floating anchor-ice is carried under the surface of the bridge ice, and accumulates until sometimes it hangs down 50 ft. from the underside, like a gigantic wasp's nest. He has found it to extend 90 ft. below the surface at the head of Lake St. Louis and at the foot of a long rapid. The explanation offered for the starting of the ice on the bottom is as follows: At first the whole surface of the St. Lawrence river is covered with sludge ice,—an aggregation of crystalized needles broken up by winds and currents and drawn together into little masses. The sludge ice passes down until the water gets cold enough to bridge the river over, the bridge forming where the current is checked. The anchor-ice glides along under the bridge, until stopped by friction or other causes, and then it freezes fast and grows downward. When the descending ice has been elbowed by the current into all the side channels, and the main current is confined into one central stream, the anchor-ice is carried down until stopped by the surface ice. In this way an inverted dam is gradually formed, which causes the river to back up until its winter level is 10 to 15 ft. above that of summer, and the wharves of Montreal are covered.

We can quote further only one interesting experience related by Mr. John R. Freeman, relating to the obstruction by anchor-ice of a hoisting turbine at the Northern canal, in Lowell, some years ago. "In the early morning, just before starting-time for the mills, the turbine speed-gate was raised so that the main sluice-gates might be opened. The turbine immediately became plugged up with interlacing needles of anchor-ice, and would not move. Thousands of operatives were waiting to begin work, and tradition states that things were in a terrible condition around that gate-house for 2 or 3 hours. Just as other means had been improvised, the sun rose high enough for its rays to fall on the water in front of the feeder to the turbine, which resulted in the starting of the latter in a short time." Here it is seen that the slight warming of the water due to the sun's rays was sufficient to make the ice let go. The fact seems to substantiate the theory that anchor-ice forms at the freezing-point of water, and that the water does not fall below the freezing-point, as Mr. Keefer asserted that it sometimes does when anchor-ice forms.

Deep-Water Route from Lakes to Ocean.

CAPTAIN D. C. KINGMAN, United States Corps of Engineers, has contributed to the *Journal of the Military Service Institution* a long and able paper upon this subject, which can only be outlined in this department. Though the military arguments for a deep water-way are briefly re-stated, Captain Kingman has appropriately entitled his paper "Engineering Aspect of a Deep-Water Route from the Great Lakes to the Ocean," the paper dealing mainly with this aspect. The proposition that "any public work which tends to put us upon an equality with Great Britain in our future ability to defend our side of the great lakes cannot fail to be a work of great importance to the common defence hardly admits of dispute, or scarcely needs any argument to support it. A deep water-way through the United States territory will admittedly effect this result. The engineering problem comprises the selection of the most feasible route, and the best and most economical construction, considered not only with reference to first cost, but also with reference to cost of maintenance and to the facilities afforded for traffic to large vessels between the seaboard and the North American inland waters."

The attempts which have been made to connect the North American lake system with western rivers in a manner which would continue the water route to the sea are classified into those which "have simply resulted in the formulation of projects," those in which "the work proposed has been accomplished," and those in which "the work of construction is now in pro-

gress." Of these the following are named: "(1) A proposed route by canal from Duluth to the Mississippi river near St. Paul. (2) The Fox and Wisconsin route by river and canal from Green Bay to Prairie Du Chien,—once actually opened, but now practically abandoned as a through route. (3) The Illinois and Mississippi canal, now under construction, which is designed to furnish a navigable water-way, seven feet deep, from Chicago on Lake Michigan to the Mississippi river near Rock Island. (4) The Illinois and Michigan canal, originally constructed by the State of Illinois, which, with the Illinois river, forms a water route from the southern end of Lake Michigan to the Mississippi at Grafton. It afforded a 6-foot navigation for vessels of not over 18-foot beam. The works now in progress by the United States, in connection with those of the city of Chicago, will ultimately make this a navigable route for the largest class of steamboats that are in use upon the river.

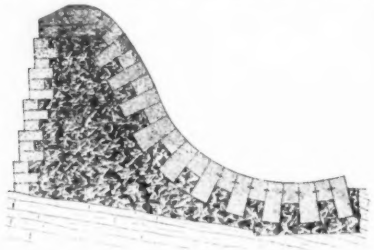
"Then there is the Wabash and the Erie canal, which connected Lake Erie at Toledo through the Wabash river with the Ohio. Like most of the older canals, it was designed for a special class of small boats. Finally, there may be mentioned a project now under consideration to connect Lake Erie by canal with the Ohio river near Pittsburgh. There may be others, but I have mentioned enough to show that the subject has been pretty thoroughly considered, and that it is highly improbable that there now remains undiscovered any particularly available canal-route between the lakes and the river."

In view of the objects aimed at in the improvements of the Ohio and the upper Mississippi, Capt. Kingman asserts that "these rivers can never become available for such ships as now navigate the lakes and the Ocean"; and he gives strong reasons for this opinion, not the least of which is that "owners of valuable and expensive ocean vessels would certainly hesitate to send them on long river voyages into the heart of the country, with a reasonable probability of their being caught by the falling water and so stranded and perhaps destroyed with their valuable cargoes, or at best held helpless prisoners for weeks or months, until released by the succeeding high-water." The conclusion is regarded as irresistible that a deep water-way by way of the Mississippi is a commercially impracticable scheme. By far the most practicable route, from the water-way through the great lakes now under construction, is to continue this from Buffalo, to and through the Hudson river via the Niagara river and Lake Ontario, going down by a series of locks from Niagara Falls,—from Lake Ontario through the Oswego river to the mouth of the Oneida river, thence to and through Oneida lake, thence over the divide to the Mohawk near Rome, and thence down the Mohawk to the Hudson. The Erie canal from Buffalo is disapproved entirely on engineering grounds, one of the principal being the proposition that "a ship canal ought to be all in excavation." Substantial arguments for this fundamental proposition are given, and from this as a basis a complete scheme of engineering for the construction of a deep water-way over the route proposed is elaborated.

New Dam at Holyoke.

AN illustrated description of the large dam about to be built across the Connecticut River at Holyoke, Mass., is given in the *Railroad Gazette* (March 8) from which the following particulars are abstracted: "The work will consist of a masonry dam 1020 ft. long and about 30 ft. high, exclusive of that portion situated in the pool below the present timber dam. The base will be about 54 ft. wide. The upper course of masonry to a depth of 5 ft. below the crest and the whole outward facing of the dam will be built of first-class granite dimension stone, as shown in the engraving, and of varying lengths, so as to properly bond on the courses below. None of the uppermost stones are to be less than 4 ft. long. Each stone is to be dowelled to the stones below by dowels made of galvanized round iron 1½ in. in diameter and 16 in. long. The stones are to be laid in full cement mortar, and all beds and joints are to be dressed for the full depth of the stone. No joints will exceed ¼ of

an inch in thickness. The cement used will be Portland cement, and the mortar will be a mixture of one part of cement and two parts of sand. The concrete used will be broken stone and mortar, five parts of broken stone not over 2 in. diameter to one part of cement in the mortar used. The facing stones, from the upper courses above described to the foot of the curved surface, are to be of similar granite to the upper courses, and will be laid in regular courses composed of two stretchers and one header alternately, except the lower course, which will be all headers. These stones will be about 6 ft. 8 in. long, 3 ft. 4 in. wide, and 2 ft. 6 in. high. Rubble stone masonry without regular courses is to be used for the interior portion of the dam and abutments, as shown in the engraving. The back of the dam is to be built of split granite laid in horizontal courses



NEW DAM AT HOLYOKE. SECTION.

with joints not exceeding ½ in. in thickness. One-fifth of this face is to be headers 4 ft. long. The outer face of the southern abutment and wing wall will consist of rock face granite dimension stone laid in horizontal courses, the rise of each course to be the same as those of the existing abutment of which it is a continuation. There will be at least one header for every 10 ft. in length of stretchers. The inner side of the southern abutment and wing wall will be faced with masonry similar to that used upon the outer side. The two upper courses will be of dimension stone. The uppermost, which is the coping course, will be of large stone. The interior of the abutment, the space covered by the section of the dam and the inner wall above the dam and up to within 17 ft. of the top, will be built of masonry similar to the interior of the dam—that is, rubble masonry, which, however, will be laid in courses, with parallel beds, instead of without courses. The northern abutment, the waste way, and the river wall are to be built of masonry similar to that of the southern abutment. On the top of the waste way a course of stone 40 ft. in length, 4 ft. in width, and 2 ft. in depth will be required. The wing walls descend from top to bottom in steps varying in depth according to the different courses. Each step will be coped with a granite block 6 ft. long.

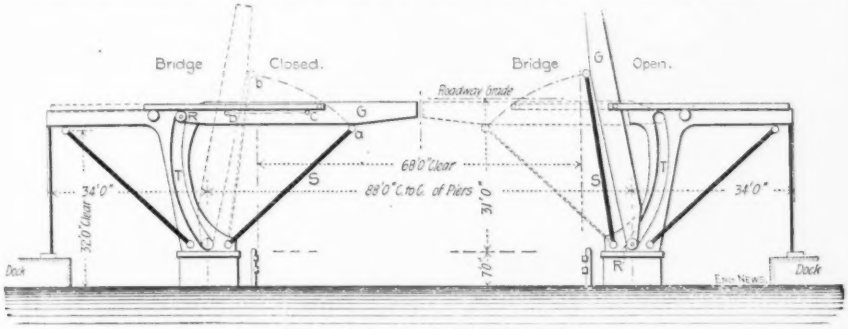
"There will be used in the dam about 34,500 cu. yds. of rubble masonry, 1825 cu. yds. of granite in the upper courses, 7000 cu. yds. of granite dimension masonry in the face of the dam, 2500 cu. yards of split granite in the back of the dam, 2300 cu. yds. granite dimension masonry in the abutments and wing walls."

Lift Bridge at Milwaukee.

A VERY ingeniously contrived bridge invented by Mr. Max G. Schinke, assistant city engineer, Milwaukee, is described in *Engineering News* (March 7) by Mr. John Geist, chief engineer of the Wisconsin Bridge and Iron Company, and designer of the bridge under notice. The principle of construction is shown in the accompanying diagram, to which our contemporary has added a half-page engraving of the completed bridge and a two-page inset of details illustrating all the features of the design. The bridge was designed for use at the Sixteenth street viaduct, Milwaukee. The reasons for the adoption of this kind of bridge follow:

"The Sixteenth street viaduct, recently completed at Milwaukee, Wis., is a structure 60 ft. wide and 4000 ft. long, connecting two densely populated portions of the city of Milwaukee, Wis., and crossing the North Menominee canal at an elevation of 38 ft. above water-line. In designing this structure it became necessary to provide for opening 68 ft. in the clear at the canal to permit the passage of large vessels to and from the coal yards and other establishments located in the neighborhood.

"Dock property being very valuable on both sides of the canal, it was out of the question to use an ordinary swing bridge, even if constructed with unequal arms, since it would prevent vessels from mooring close to the bridge, and would otherwise obstruct the channel, which at this point is quite narrow. It was also thought advisable to locate the opening as near the middle of the stream as possible." Referring now to the diagram, the mechanical features of the bridge may be said to consist of main girders *G*, upon which the roadway floor is supported, swinging struts *S*, each hinged to the girders at one end while the opposite end is hinged or pivoted to the base of the corresponding upright resting on the pier, and rollers *R*, attached to the ends of the girders opposite the ends near which the swinging struts are connected with the main girders, these rollers bearing upon and working in curved tracks *T*. Obviously, when the inner end of either part of the bridge is lifted, its rollers will go to the bottom of the track; and the reverse when the same end is again lowered to its normal position. The arrangement is ingenious, and seems well adapted to situations like that described. Its advantages are summed up by Mr. Geist as follows: "(1) It permits a floor of the heaviest kind, with paving, or of asphalt and concrete on buckle plates, without making the bridge too dangerous to operate, since there is perfect balance of the moving portion at all times and seasons. (2) On account of the peculiar motion of the swinging portion, the effects of wind forces are much reduced, and can be easily controlled. (3) The central deflection is small, due to the supporting swinging struts. (4) Both ends of streets or approaches are closed by the bridge floor when the bridge is opened. (5) It requires no center pier, and permits a single wide channel for vessels. (6) This construction requires no towers projecting above the roadway and obstructing the view of the river."



LIFT BRIDGE AT MILWAUKEE, WIS.

"The undertaking is a stupendous one, contemplating as it does the reclamation and settlement of a veritable empire,—a valley 165 miles in length. To accomplish this a system of irrigating canals with an aggregate length of 1200 miles has been built, together with a series of reservoirs impounding 6,300,000,000 cu. ft. of water. One of the reservoirs of this series is the largest in America, and is exceeded in size only by the Periar reservoir in India. At least 400,000 acres of land will be reclaimed, and ten thousand families will be provided with homes and the chance to secure a competence. Seventy-five thousand acres have already been settled upon in the valley, and the settlers are profitably engaged in raising standard crops,

Irrigation in Pecos Valley.

ACCORDING to an article in *The Railway Age* (March 1), one of the most extensive schemes now being worked out in the arid regions of the United States is that of the Pecos Irrigation and Improvement Company and other associated corporations in Pecos valley in southeastern New Mexico.

particularly alfalfa, which grows in utmost luxuriance, together with fruits which are disputing preëminence with those grown in the most favored sections of the country. Very satisfactory progress is being made at the present time in the valley's settlement, the fertile lands being rapidly taken—in the main by a good class of farmers and fruit-growers, principally from the middle west. The valley, which six years ago was an unbroken, barren plain, practically uninhabited, is to-day dotted with farms; while towns and villages are springing up in many places in which the foundations of prosperous communities are being laid. The Pecos valley is also expected to become one of the most prominent sanitarium centers of the Rocky mountain region, as it combines preëminently favorable climatic conditions with opportunities for profitable occupation."

An important work in connection with the great reclamation scheme of irrigation is the extension of the Pecos Valley Railway from Roswell, its present northern terminus, on to Washburn.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Bridges.

29361. London Bridge. Anon. (A A-Feb. 16.) 2200 w.

29492. A New Bridge Over the East River at Blackwell's Island, New York. Ill. (Sc A-Feb. 23.) 700 w.

29681. The Tolbiac Street Bridge at Paris. Ill. (Sc A S-March 2.) 900 w.

*29847. London Bridges, Architecturally Considered. Ill. H. H. Statham, with Discussion (B-Feb. 23.) 14000 w.

29887. Suspension Bridge Over the Hudson River at New York (Ir Age-March 7.) 1300 w.

29927. The Lift Bridge of the Sixteenth Street Viaduct, Milwaukee, Wis. Ill. John Geist (E N-March 7.) 1300 w.

29935. The Hudson River Bridge Specifications (R G-March 8.) 4500 w.

Canals, Rivers and Harbors.

29219. Another Ship Canal Project. Editorial (R A-Feb. 8.) 500 w.

†29228. Engineering Aspect of a Deep Water Route from the Great Lakes to the Ocean. D. C. Kingman (J M S I-March.) 9000 w.

29303. The Illinois and Mississippi Canal Lock Works. Ill. (E N-Feb. 14.) 4400 w.

29326. A Discussion on Anchor Ice. Remarks made in the Discussion of John R. Freeman's Paper (E R-Feb. 16.) 1500 w.

†29490. Canal Towage in France. Anon. (I Eng-Jan. 19.) 2800 w.

29569. The Stability of Crib Breakwaters.—From the Annual Report of James F. Gregory (E R-Feb. 23.) 1800 w.

29682. To Improve New York's Canals (Sea-Feb. 28.) 2200 w.

29698. Ship-Canal Projects at Seattle, Wash. Eugene Ricksecker (E N-Feb. 28.) 800 w.

29922.—$1.50. Improvement of Gray's Harbor, Wash. Ill. Bolton W. De Courcy, with Discussion (T C E-Dec.) 5800 w.

29934. The New Holyoke Dam. Ill. (R G-March 8.) 500 w.

Hydraulics.

*29149. Water Powers of the Western States Ill. A. G. Allan (E Mag-April.) 4000 w.

29518. The Development of Percolating Underground Waters. Extracts from papers by L. M. Holt and George Manuel (E N-Feb. 21.) 4800 w.

29546. The Cracks in the Reservoirs at Portland, Ore. A. L. Adams (E N-Feb. 21.) 900 w.

29672. The Variation of Pressure in Cornish and Other Pumps. G. E. J. McMurtrie (C M R-Feb.) 2000 w.

Irrigation.

†29485. The Russellkonda Project. Ill. (I E-Jan. 19.) 600 w.

29765. The Pecos Valley.—Some Account of the New Region Being Developed in New Mexico (R A-March 1.) 2000 w.

Miscellany.

29493. The Institution of Civil Engineers, London.—Rebuilding, etc. Ill. (Sc A S-Feb. 23.) 200 w.

29502. Portland Cement. Howard Fleming (S V-Feb. 15.) 700 w.

29517. Materials for Hydraulic Concrete and Best Methods of Mixing. C. H. Platt (E N-Feb. 21.) 1000 w.

*29820. Masonry Dams. Editorial (Eng L-Feb. 22.) 2500 w.

Serials.

27071. Graphic Method of Taking Out Areas. Banks and Cuttings. R. E. (I E-Began Oct. 27—2 parts to date—45 cts. each).

28495. Blackwall Tunnel. Anon. (E-Began Jan. 4—3 parts to date—30 cts. each).

28498. Thames Bridges. Ill. (E-Began Jan. 4—5 parts to date—30 cts. each).

29325. Van Buren Street Rolling Lift Bridge. Ill. (E R-Began Feb. 16—2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Explosions of Domestic Boilers.

AN editorial in *Engineering* (Feb. 15) indicates that explosions of domestic boilers in England are frequent enough to call for editorial comment in a high-class engineering publication. On February 7 there were 4 such explosions; in 3 days there were 14. On February 10 there were 2, and on the 11th 4. The results, exclusive of notable damage to property, were the death of 6 persons and injury to 24. It is asserted that "last winter, in the course of 2 short frosts, 19 people were killed and 54 injured"; and it is added that "all these accidents, with their attendant deaths, sufferings, and disfigurements, would have been avoided if each boiler had been equipped with a safety-valve costing only a few shillings." Just how these explosions occur is explained in the following quotation:

"Each succeeding night has tightened the grip of frost, and has enabled it to penetrate further into houses and buildings, and here and there to freeze up the circulating pipes in the cold hours of the early morning, when the kitchen fire has died out. Just before breakfast time the cook, cold and sleepy, has lighted the fire, and has urged it to the best of her ability by drawing out the dampers, in order that she might have the hot water required in her department. She has no possible means of knowing if the pipes are free or not, and her only test is, as a rule, one that puts her life to the hazard. If the pipes are free, all is well; but, if the frost has sealed them, the house is wrecked, and, possibly, some of its inmates killed."

It is the kitchen boilers—not those used for heating—that are playing this mischief. Such accidents are rarely heard of in the United States, though frost is much more general and frequent in the northern portions than in England. Safety-valves on kitchen boilers are not commonly used here. Boilers in kitchens frequently collapse under atmospheric pressure when water is drawn off in street-mains and when there has been neglect to vent them by opening faucets; but an explosion of such a boiler is an extremely rare occurrence. Nevertheless, a condition of things implying danger can be imagined. It would not, however, be precisely such as *Engineering* describes. Kitchen boilers are for the most part so connected with the water-backs or fronts of ranges that any total obstruction to their supply pipes will prevent water from running out of the hot-water faucets. Simply opening one of these faucets will show, therefore, whether the supply pipe is free or not. If free, the water in the boiler, when the pressure increases unduly, will back out of the boiler, relieving the pressure. If a hot-water faucet be allowed to run, a supply of cold water is constantly fed to the boiler while the faucet is open, so that undue pressure cannot be generated. Evidently transatlantic plumbers might learn something in the matter of kitchen boilers from American practice.

These accidents have become so numerous in England that their prevention has been discussed by the Board of Trade. Curiously, inquiries by the board into the causes of special accidents of this kind were seriously objected to, on the ground that it would be an unwarrantable interference with private domestic affairs. Mr. Bryce suggested that theorists of the type of Mr. Herbert Spencer would raise objection to the interference of the State with regard to what happened in a private dwelling; that "an Englishman's house was his castle"; and that very wide questions were opened by the proposal. To this *Engineering* very pertinently makes answer that "this objection appears to be based purely on sentiment; it is unsound even in theory, and is contradicted by daily experience of the practical working of the law. Though a householder possesses many sacred rights which are wise safeguards, and should be preserved invio-

late, yet there is no law which allows him to do just what he likes, even in his own house. It was not suggested, however, that there should be interference or espionage in every man's dwelling, although, had there been, it would not have exceeded the powers held, and actually exercised daily, by many gas and water companies and by sanitary authorities. The 'castle' theory, as applied to the house of the town-dweller, is pretty well played out, when at least three separate sets of inspectors can override it. Further—and here we come nearer the point at issue—should a domestic boiler explosion occur with fatal results, no sentiment can exclude the coroner and his jury of twelve, who can enter the house and inquire into the origin of the loss of life." Evidently the explosion of kitchen boilers in England is a subject of no insignificant character, since it gives rise to such a debate.

Bedding-Plants.

THIS is the time of year, in latitudes above 40°, for the beginning of spring and summer gardening. The hints relating to the bedding of plants given in an article by Mr. Samuel Parsons in *Scribner's Magazine* for March are therefore timely and useful. "Custom is rapidly doing away with set pieces of cut flowers, artificially and stiffly combined; why," asks Mr. Parsons, "should we not have a similar reform in the use of bedding-plants? Because gardeners of great skill and knowledge succeed in making wonderful combinations of form and color with bedding-plants, which combinations are also artificial, formal, and unnatural, shall we give up altogether one of the most delightful of summer effects?" He intimates that this is the tendency at present. "Crusades against bedding-plants have been carried on by persons of knowledge and taste,—persons whose genuine love and comprehension of the best landscape-gardening ideals cannot be questioned." Without quoting more of the argument, it may be said that many have doubtless felt that good taste was offended by the Persian-rug effects of many of the flower-beds in our public parks, as well as the geometrical patterns in which some gardeners seem to delight. Nature had little regard to geometry when she scattered her flowers over the face of the earth, which was in bloom long before looms or embroidery were thought of. True art in the adornment of parks and grounds will be best attained by such a distribution as produces natural, not strained and artificial, effects.

"Not only must the relations of bedding-plants and shrubs be considered, but the composition of the individual bed of plants must be carefully worked out. You must have a system and be governed by certain general rules, but there must be no mannerism or adherence to any hard-and-fast line of treatment. Every new problem must be studied with regard to its own inherent peculiarity. . . . As a rule, the large plants in a bed should stand in the middle, or at the back, of the group, set against a building or fence. First should come, as in all plant-combinations on the lawn, the lesser effect of grass,—something a few inches high, like alternanthera; then the next greater or small shrub effect, like that of geranium and coleus; then the large shrub effect, like the acalypha and salvia; and finally the tree effect, like the canna and musa. To this general rule you will adhere, but with marked variations that will seem almost at times like transgressions of your most fixed principles. Canna and musa will thrust themselves forward almost, but never quite, to the border of the group, always keeping the acalypha and geranium effect, though ever so narrow, between it and the grass. The acalypha will throw out at times promontories of foliage beyond the foreground itself, and drop one or three plants to grow in isolated places outside of the group on the grass. Geraniums and coleuses will stray across the alternanthera border continually, to overcome all monotony of outline. And yet all through you will find a general adherence to the principle of large plants to the back and small to the front. Only, as you want to treat your bedding in a natural and artistic way, you will continually seek to vary the forms as well as colors, to blend and con-

trast in such a manner as to surprise and delight in a hundred ways without the slightest trace of monotony or mannered designs. Formalism there is undoubtedly, but it is the formalism of the copes and the forest dell. To explain just how to make these thoroughly artistic arrangements of bedding-plants is, of course, impossible. The painter might just as well attempt to explain how he paints a picture,—how he manages his lights and shades and masses his colors. Practice, experience, and natural aptitude for producing artistic effects, and, above all, the study of the best models, will alone give the desired facility."

The article treats at considerable length of the most available bedding plants, explains the laying-out and designing of beds, and is accompanied by numerous diagrams, and many illustrations of planting that are considered good examples. No circle, horseshoe, harp, anchor, cross, or crescent pattern is to be found among these graceful models. Such artificial, strained effects are justly condemned.

The Heating and Ventilating Engineer.

IN a beautiful souvenir number, our esteemed contemporary, *Heating and Ventilation* for February, devotes nearly the whole of its space to the proceedings of the first annual meeting of the American Society of Heating and Ventilating Engineers. The papers read at this meeting indicate that this young society is destined to rank among the foremost engineering associations of the United States. As one looks over the array of heating and ventilating literature presented at the meeting, the paper by Mr. Stewart A. Jellett particularly attracts attention. Leaving the technical side of the profession to be ably dealt with by others, he discusses business aspects, finding that many abuses "and unbusiness-like methods" have crept in. He called the attention of the meeting to the fact that the old maxim, "competition is the life of trade," is capable of misinterpretation. "Competition can overreach itself and become the death of trade, and unregulated competition is to-day the bane of many branches of engineering, and particularly our own. I quote from the Bulletin of the National Association of Builders: 'While we are all competitors, we should still stand firmly together for the correction of errors in practice, and in principles of action.'

"The business of heating and ventilation, as carried on to-day, is capable of three divisions: (1) the engineer who plans and supervises only; (2) the engineer who contracts only; (3) the engineer who does both. The first is dependent wholly for his income from fees received for services, and he is consequently affected by the business methods of the third, who plans as well as contracts. The second looks solely to the profits of his contracts for his remuneration, while the business of the third, if rightly conducted, should pay a profit in each division."

Among the prominent abuses which have injured the profession is "the practice of making plans and specifications for architects and owners free of expense to them. The committee who drew our constitution were impressed with the necessity of correcting this (see article 1, subdivision 8); 'to establish a uniform scale of prices for all professional services.' The scale is nearly uniform now, I regret to say, but, like the winds of heaven, uniformly free to all. I have heard contracting engineers say that this custom has obtained such a firm hold that to refuse to render such services free would kill their contracting business. You can all readily see the effect of such an unbusiness-like practice. It largely kills the business of the consulting engineer, and it takes a large part of the legitimate profits made in contract work to meet the expense of making these plans and specifications. Many of our architects have one or two concerns to whom they send their building plans regularly to have the heating and ventilating and power systems carefully worked out, but with no thought of paying for such services. There is no sound reason why this abuse should not be at once corrected, and there are good reasons why it should be. First, it is unfair to the consulting engineer, who manifestly cannot render such services free. Second, it

is unjust to the general customers of the contracting engineer who does it, as the expense of doing it must come from the work done for them, and for which they are paying. Third, it places the architect who accepts such gratuitous services in a position to be justly criticised, as he must either be unfair to the engineer from whom he accepts the service, for which he himself is being paid, or he must be unjust to his client, if the acceptance of such service affects his judgment in deciding the award of contracts for the work. Fourth, it is not business, viewed from any standpoint, and is unjustifiable. Let us, therefore, not adjourn this our first annual meeting, until we have taken the necessary steps for an immediate and radical change in this department."

The present forms of specifications are also criticised. "If any thing or any requirement cannot be accurately defined or stated, it ought to be left out of the specifications entirely. Whatever is required should not be left to be summed up in some indefinite clause like the following: 'The material and workmanship throughout must be entirely satisfactory to the owner and the architect, and the system must be guaranteed in every respect to do the work asked for to their satisfaction.' Who can estimate what it will cost to do anything to another man's satisfaction,—one whom possibly he does not know? This practice came into use in the days when heating was largely a matter of faith in the party employed to do the work, and when there was no general or definite knowledge of the subject. It is the outgrowth of methods that do not exist today, and its use should be dropped. The buyer should be required to decide whether the thing he is asking you to do, when done as specified, will be satisfactory to him or not." The usual guarantee of temperature required by owners from contractors is also objected to, especially for plans and specifications drawn by some one other than the contractor. Inferior material and other abuses are touched upon, and altogether the paper is one that heating engineers will do well to carefully consider. This advice is strengthened by the approval which Mr. Jellett's paper received in the discussion that followed the reading.

Radiating Surface in Hot-Water Heating.

IN a paper dealing with the subject of "Hot-Water Heating," in which this method of heating is discussed historically, theoretically, and practically, read by Mr. James Mackay before the Steam Fitters' Protective Association at Chicago (Feb. 18), and printed in *The Metal Worker* (March 21), the author, after stating that hot-water was used by the Romans for heating buildings 1800 years ago, and tracing the history of the method up to the present time, treats the practical side of the subject with reference to the two systems (high-pressure and low-pressure) now in use, the appliances for each, etc. With reference to the apportionment of radiating surface Mr. Mackay says: "The wall surface may be reduced to its equivalent in glass surfaces and the whole figured as so much glass, or each factor may be treated separately. The latter plan I consider best. In apportioning direct radiation to a given room, in which it is intended to maintain a temperature of 70°,—and in the water of the heating apparatus a temperature of 160°,—it has been my experience that 1 sq. ft. of radiation to each 60 cu. ft. of contents, 1 sq. ft. to each 2 sq. ft. of glass, and 1 sq. ft. to each 8 or 10 sq. ft. of outside wall, will do the work properly. Great care must be exercised in judging as to the exposures, construction of the walls, and fitting of doors and windows, together with any local conditions which might affect the result, and due allowance made. If a temperature of 200° be carried in the water, the radiation may be decreased about 20 per cent. To ascertain the amount of direct-indirect radiation required for any given room, the usual method is to ascertain the amount of radiation required, and to this amount to add 25 per cent. I have found under these circumstances that each radiator should have a cold-air duct of an area in the ratio of 40 sq. in. to each 100 sq. ft. of radiation. This duct should be brought through the wall a little above or below the radiator, so that it will make a right-angle

turn before entering the base of the radiator. It should be accessible for inspection and cleaning purposes. Air can be delivered through a direct-indirect radiator at a velocity of about 3 ft. per second. Indirect radiation is usually apportioned by adding 50 per cent. to the amount of direct radiation required. This calculation would answer, if wrought-iron surfaces were used, but it is entirely inadequate for heating purposes if cast-iron indirect radiation, taken at its commercial rating, is used. In such a case I should recommend increasing the amount required for direct radiation 100 per cent.; then the amount will not be found any too liberal." Warm air ducts from indirect radiators are often faulty in size. They should be approximately 1½ in. in area for each square foot of the radiating surface of the radiator to which they are connected up to the first floor, 1¼ in. in area per square foot of radiating surface to second floor, and 1 in. in area per square foot of radiation to third floor. The cold air duct may be from 25 to 33 per cent. smaller in area than the sum of the areas in the warm air ducts calculated by the rule. The boxing in of the radiators should be such as to make all their surface effective, that is to say it should be done in such manner as to compel equal distribution of air uniformly over every part of the heating surface.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Heating and Ventilation.

29234. The Heating and Ventilating Engigineer.—A Commercial View. Stewart A. Jellett (H & V–Feb. 1.) 1800 w.

29280. Heating and Ventilation in the Public School Buildings of Chicago. Ill. Anon. (M S F–Feb.) 1700 w.

29328. Diagram for Proportioning Heating and Ventilating Ducts. Ill. Carl S. Fogh (E R–Feb. 16.) 2800 w.

29329. An Explosion of a House Heating Boiler, at 308 West 75th St., New York (E R–Feb. 16.) 600 w.

*29387. Hot Air Furnace Heating. By a Practical Furnace Man (D E–Feb.) 1000 w.

29426. Combination Heating for School Houses. W. H. Pennell (H & V–Feb. 15.) 900 w.

29427. Ventilation in New York City. Fred P. Smith (H & V–Feb. 15.) 1400 w.

29430. Some Data Concerning Furnace Systems. S. P. F. (H & V–Feb. 15.) 1400 w.

29730. Hot Water Heating. James Mackay (Met W–March 2.) 4200 w.

29782. Ventilation and Heating of the Residence of Mr. Cornelius Vanderbilt. Ill. (E R–March 2.) 2000 w.

*29853. Warmth and Draughts. Anon (I C B–Feb. 22.) 1000 w.

*29854. The Ventilation of Sitting-Rooms. H. T. Munday (I C B–Feb. 22.) 1400 w.

Landscape Gardening

*29532. Bedding Plants. Ill. Samuel Parsons, Jr. (Sc M–March.) 3000 w.

Plumbing and Gas Fitting.

*29386. Organization of Master Plumbers' Associations and the Proper Limit of Their Actions. S. E. Dibble (D E–Feb.) 1200 w.

29575. Rules for Plumbing at United States Military Posts (E R–Feb. 23.) 1000 w.

*29608. The Plumber. Anon. (I C B–Feb. 15.) 1200 w.

29883. Cutting Nipples. Ill. William Beall (S P–March 1.) 2500 w.

Miscellany.

*29632. Domestic Boiler Explosions and the Board of Trade. Editorial (E–Feb. 15.) 2000 w.

29669. The Defacement of Scenery. Editorial (G & F–Feb. 27.) 1400 w.

Serials.

26907. Hot Water Heating and Fitting. Ill. J. L. Saunders (H & V–Began Nov. 15—4 parts to date—15 cts. each).

27214. Combination Heating. Ill. J. W. Hughes (Met W–Began Dec. 1—4 parts to date—15 cts. each).

27783. Mechanical Heating and Ventilation. M. C. Huyett (I A–7 parts to date—45 cts. each).

29076. Installing Wood-Cased Bath Tubs. Ill. Grayson (S P–Began Feb. 1—2 parts to date—15 cts. each).

29077. Practical Gas Fitting. Anon. (S P–Began Feb. 1—2 parts to date—15 cts. each).

29281. Steam Heating as Practiced in the United States. David Nesbit (M S F–Began Feb.—1 part to date—15 cts).

29334. Technical Subjects that Plumbers Should Know. F. Dye (Pl D–Began Feb.—1 part to date—30 cts).

29429. The Warming of Residences. Zero (H & V–Began Feb. 15—1 part to date—15 cts).

We supply copies of these articles. See Introductory.

ELECTRICITY

Electrical Engineering at Home and Abroad.

AT a recent meeting of the Institute of Electrical Engineers a notable paper was read by H. Ward Leonard, under the title of "Notes on Recent Electrical-Engineering Development in France and England," which is published in the February number of the Society's *Transactions*. As a result of his observations, Mr. Leonard expresses the opinion that from an engineering standpoint America is rapidly losing the lead which it has heretofore maintained in the race of electrical development. He considers the three most important epochs in American electrical progress to have been the establishment of Edison's first three-wire plant at Sunbury in 1883; of Westinghouse's first alternating plant at Buffalo in 1886; and Sprague's first electric railroad at Richmond in 1888. What, asks Mr. Leonard, has been done in this country in the way of remarkable electrical-engineering development since these dates? He answers by affirming that in this country the practical development of electrical-engineering improvements—meaning presumably those of an original or radical nature—is well-nigh impossible by reason of the opposition of the gigantic corporations which seek to control the whole field, and that corporations having so large a proportion of their capital represented by patents do not desire the practical trial of a promising improvement which they do not control, and which may depreciate the value of methods which they do control or claim to control. It is for this reason, Mr. Leonard thinks, that we are now losing ground as compared with England and France. On his hurried trip abroad, he remarked many instances of inventions of American engineers which had proved highly successful, and which, although patented, described, and advertised in America, had been first taken up by English or French engineers, notwithstanding their well-known prejudices against American inventions. In England there is a multitude of medium-sized manufacturing concerns, and the competition seems to be rather upon ideas than upon the price of dynamos per kilowatt. Mr. Leonard was somewhat surprised to find generators and motors much cheaper in the United States than in England or France, nothwithstanding the advantages of these countries over ours in respect to cheaper materials and labor. Rotary transformers are used in several stations for a continuous-current, high-potential, multiple-arc distribution, and in some places the standard 220-volt three-wire system is supplemented for distant lighting by an alternating system using 2000 volts in the primary and a 220-volt 3-wire secondary, which, during the period of light load, is switched directly on to the regular 3-wire system. The steam-turbine is gaining favor abroad as a motor for electric-lighting plants. A station of twenty-five thousand lights at Newcastle-on-Tyne has been operating solely by Parsons's turbines for 5 years and paying regular dividends. Similar turbines have also been recently placed in one of the London stations of the Metropolitan Company, and are found to be no less economical than the compound condensing reciprocating engines which they superseded. Mr. Leonard examined a storage-battery plant in Paris, capable of supplying 8000 10-c. p. lamps for 3 hours. It cost $30,000 and weighed 400,000 lbs. It was well-designed and seemed to be in good order. He is not surprised at the assertions as to the inefficiency of transatlantic stations which do not use batteries; inasmuch as, owing to the limited use of motors abroad, most of the central stations are run practically without load the greater part of the 24 hours. He puts this matter very forcibly when he says: "The portion of the total cost of each kilowatt-hour produced, which depends upon the maximum load, is about two thirds of the total cost, and the part dependent upon the actual output is only

about one-third. The average load-factor in an English central station is less than 15 per cent., and only rises to 33 per cent. in London in December, while in most American cities it is 50 per cent. or more. Among other matters, Mr. Leonard carefully investigated the Heilmann electric locomotive, of the possibilities of which he speaks with great enthusiasm. Space forbids a summary of his observations upon this peculiar machine, but it is probable that the early practical trial of the scheme will show whether Mr. Leonard's somewhat sanguine expectations are likely to be fulfilled.

Electrical Education.

PROFESSOR EDGAR KIDWELL of the Michigan Mining School has a very excellent paper on the above subject in the *Electrical Engineer* (Feb. 13), written by way of comment and criticism upon a previously published article on the same subject by Professor Stine of the Armour Institute. The author takes vigorous exception to the far too common practice of introducing irrelevant matter into papers read before engineering societies. "Most engineers," he says, "have far too little time for private study, and it is all important that he who writes for them bear that fact in mind, drop all useless attempts at flowery language, stick close to the subject, present clearly and accurately the matter under discussion, go straight to the point, and not waste the reader's time, or distract his attention, by lugging in illustrations, comparisons, etc., which show nothing, but only befog the understanding." Referring to the methods of instruction in many of our technical schools, the author makes the eminently judicious observation that "today one of the greatest stumbling-blocks to progress in most electrical-engineering courses is that a large amount of the professor's time has to be wasted in giving the kind of elementary instruction which had better be done in the department of physics." The ground which had been taken by Professor Stine—*viz.*, that the course of instruction for an electrical-engineering student should be confined principally to electrical matters (mechanical engineering, shop practice, etc., being excluded, or else given in a very elementary manner, "since proficiency in these latter branches is not now essential to the electrical engineer, or at least is less important than it was formerly")—is severely, but justly, criticised by Professor Kidwell. He says: "He who desires to succeed as an electrical engineer must of necessity be an adept in many branches of mechanical engineering. He must know the general principles of *all* engineering, and no amount of electrical knowledge alone will make him an engineer any more than a knowledge how to turn up governor-balls will make one a machinist." Again he says: "No course in electrical engineering, irrespective of the thoroughness with which the electrical work alone is done, can properly prepare men for active practical engineering work according to the requirements of today, unless such a course includes a thorough training in the fundamental principles of mechanical engineering. . . . There are today stations running and giving good satisfaction, which are directed by mechanical engineers of rather limited electrical attainments. I can recall some others run entirely by the electrical end of the concern. No customer dares dispense with his oil lamp, for the regular programme seems to include a shut-down about once a week to tinker with some hot box, etc." Such a discussion is calculated to do much good, but there can be no doubt that the views of Professor Kidwell will be strongly endorsed by all experienced electrical engineers.

Electrical Illumination of Churches.

THE Roman Catholic church has always had the reputation of being an extremely conservative organization, yet it is interesting to remark that in the decorative utilization of that extremely modern illuminant, the electric incandescent lamp, in some of its principal places of worship, it easily takes precedence of its sister churches. In *Electricity* (Feb. 20) R. M. Bernard tells in a very attractive way how science and art have joined hands in the embellishment of some of the principal tem-

ples of worship of this communion in the city of New York. The pioneer in this particular field of work was Mr. D. Colombani, formerly of the Edison Illuminating Company, and his first undertaking of the kind was in the Church of the Holy Innocents in West Thirty-seventh street, which was completed near the end of 1889. It was not, however, until Mr. Colombani had obtained *carte blanche* to carry out his own ideas and conceptions in the decorative illumination of St. Francis Xavier's on West Sixteenth street that he was able to fully demonstrate the wonderful possibilities of the new illuminant in this direction. Since that time he has successively carried out similar installations in several of the principal churches in New York and Brooklyn, each of which, having its individual architectural peculiarities, afforded a wide scope to the artistic genius of the designer. In undertaking the illumination of an altar, a statue, or any special architectural feature, the artist always set himself the task of bringing out by the aid of electric lamps the particular points which, for ecclesiastical or other reasons, it was desirable to emphasize. Mr. Bernard's article contains descriptions of a number of these features, and is accompanied by excellent and artistic illustrations. Some of these special designs are conceptions of high artistic merit. and, moreover, show great skill in the adaptation to them of the desired character of illumination. It is a paper which church architects may study with pleasure and profit.

Arc-Lighting Up to Date.

ELECTRICAL INDUSTRIES (Feb.) contains a well-written and well-illustrated article descriptive of the new arc-lighting plant of the Mutual Electric Light and Power Company of Chicago, which is notable as marking a distinct departure, in many important respects, from the hitherto generally accepted practice in the United States, in the engineering and equipment of stations of that type. The arc dynamos commercially operated in this country fifteen years ago were run at a speed of more than one thousand revolutions per minute, and, as the only engines then made in other respects suitable for the purpose were practically limited to a speed of some two hundred and fifty revolutions, it became necessary to employ belting and countershafting,—a practice which has been largely followed down to the present day. During all the intervening years the dynamo-designers have endeavored to reduce the speed of their machines, while, on the other hand, the engine builders have sought to increase their speed, until at length the engine and dynamo, so to say, have been brought together, and the new station, now described, is the successful result of this advantageous mutual adjustment. The Brush Electric Company has produced an arc dynamo having a capacity of 125 2000-c. p. lights, the speed of which is only five hundred revolutions per minute, while the M. C. Bullock Manufacturing Company has brought out an engine of the Willans type of equal speed, and in all other respects admirably adapted to the required service. It is worthy of note that in this process of evolution the engine and dynamo have, as it were, met exactly at the half-way point; the speed of the engine has been exactly doubled, while that of the dynamo has been cut in half. The engine and dynamo are now mounted upon one bed-plate, and occupy a floor space of only about 45 sq. ft. Three of these combinations constitute the present plant of the Mutual Company. The district lighted is a residence section of Chicago, 46 sq. miles in area and containing a population of nearly 300,000. The article gives full details of the construction of the engines, boilers, switch-boards, and minor appliances, which, although severally of more than usual excellence, appear to present no features calling for special mention here. One of the most striking illustrations accompanying the article is that showing a ground plan of the very common arrangement of a Corliss engine belted to two dynamos, and on the same scale, for convenient comparison, the Willans engine driving directly a single dynamo of equivalent capacity. The respective areas of floor-space occupied are exactly as eight to one. In fact, under the new organiza-

tion, only 1 sq. ft. of floor space in the central station is required for each 2000-c. p. light operated, while the economy in other directions is very great. There can be little doubt that in future this will become a standard and representative type of the larger class of arc-lighting stations, and, as such, will repay careful study by electrical engineers and designers.

The Electrical Industries of Cleveland.

THIRTY years ago, when telegraphy was practically the only recognized electrical industry, Cleveland was the headquarters of the Western Union Telegraph Company,—then, as now, the largest electrical corporation of the world. Naturally there grew up in that city shops for the manufacture of various telegraphic and electrical instruments and appliances, and in this way it happened that, when Mr. Charles F. Brush had designed the dynamo machine and system of arc-lighting which have made his name a household word throughout the civilized, to say nothing of many portions of the uncivilized, world, he entered into business relations with a concern in the city of his residence, already engaged in this kindred line of work, for the manufacture and introduction of his inventions. From this beginning grew up the Brush Electric Company, at one time the principal establishment in the world engaged in the manufacture of electric-lighting appliances. Thus Cleveland has always been peculiarly a city of electric manufactures. In view of the recent meeting in that city of the National Electric Light Convention of central station managers, the *Electrical Engineer* (Feb. 20) devotes a large amount of space to a series of illustrated articles, some of them of a very elaborate and interesting character, relating to the electrical industries of Cleveland, as well as to the personal histories of some of the men who have been prominently identified with the establishment and management of these enterprises. The Brush interests, as a matter of course, are accorded the place of honor in the list. Over 150,000 arc-lamps are nightly burning in the streets and public places of our cities and towns, the product largely of this immense establishment. Twenty-six million arc-carbons were made by this company in 1893. The newly-completed factory of the National Carbon Company is also described. It covers 26 acres of floor-space, and comprises fourteen buildings,—some of them of enormous dimensions. Its total capacity is two hundred million carbons per annum. Other prominent establishments described and illustrated are those of the Buckeye Lamp Company, the Walker Manufacturing Company, the Universal Electric Company, and the Elwell-Parker Electric Company of America. Interesting articles are also given containing descriptions of the technical schools for which Cleveland has acquired such a deservedly high reputation, among which are the Case School of Applied Science and Professor E. P. Roberts's Correspondence School of Technology. Practical electrical engineers will also find much of interest in the illustrated descriptions of the new plants of the Cleveland Electric Illuminating Company, and of several of the electric-railway plants of that city. It must be admitted that in matters electrical Cleveland makes a fine showing.

Death of An Electrical Pioneer.

IN the *Electrical Engineer* (March 6) Franklin L. Pope has a brief biographical sketch and portrait of Royal Earl House, an inventor of consummate ability, prominently connected with the early history of electric telegraphy in this country, who died in Bridgeport, Conn., on February 23, at the age of 81. House achieved fame and fortune as the originator and constructor of the earliest successful type-printing telegraph, first invented in 1844 and finally perfected in 1848,—a perfect marvel of mechanical and electrical skill, which was capable of printing communications in Roman characters, at a rate of over fifty words per minute, by the action of compressed air controlled by electricity, and of keeping up this rate of work for an indefinite period. Both as an electrician and a mechanician House may fairly be said to have been a quarter of a century in advance of his contemporaries. For the past

forty years he has lived a retired life, occupying himself largely in the development of an automatic system of telegraphy, which, however, failed to meet with commercial acceptance. He was a man of fine physique and attractive personality, and one whose work in the history of electrical development was of sufficient importance to entitle him to rank among the foremost inventors of the nineteenth century.

Electric Annealing of Armor Plate.

ARMOR plates which have been subjected to the Harvey process are covered with a skin of hard steel of half an inch or more in thickness, and it has been a serious question how such plates could be locally annealed so that they could be drilled and tapped at points necessary for the insertion of bolts or other fastenings, especially as the application of the most intense heat that could be produced by the oxy-hydrogen blow-pipe has proved to be wholly ineffective for the purpose. In the *Electrical Engineer* (March 6) Professor Elihu Thomson tells how this difficult problem has been solved by Mr. Herman Lemp, an expert in electric-welding processes. Mr. Lemp's method consists in passing a current between two electrodes placed a certain distance apart and in contact with the surface of the plate, and thus heating a portion of the plate to an annealing temperature, after which, by a very careful diminution of the current, the temperature is slowly lowered so that the too rapid cooling by conduction of heat to the mass of the plate back of the heated portion shall be prevented from acting as a chill on the heated metal. The use of alternating currents derived from a transformer, as usual in welding processes, favors the concentration of the heating effect and the local flow of current. The reactive inductive effect is least where the current flows near the surface of the plate from one electrode to the other, so that any current seeking to diverge from the direct path and enter more deeply into the substance of the plate has to traverse not only a longer path, but one in which self-induction acts to limit the flow. The value of this process was demonstrated in the case of the war-ship "Massachusetts" under construction at the Cramp yard, it having been found that certain plates for the barbette were hard where it was absolutely necessary that they should be drilled and tapped. The building of the upper deck of the vessel was delayed, while experiments were vainly made with the blow-pipe to soften the plate so as to permit of drilling. The application of the electric process solved the problem at once, and Mr. Lemp's apparatus will doubtless soon become one of the essential features of the equipment of a modern ship yard.

Electricity on Ordinary Railways.

THE *Electrical Engineer* (Feb. 13) prints a number of communications from such authorities as Professor Elihu Thomson, Messrs. Houston & Kennelly, and H. Ward Leonard, expressing their respective views as to the problem of applying electricity to the operation of standard railways, and giving their reasons therefor. Professor Thomson favors overhead conductors, and advocates the self propelling motor car for local and suburban traffic, and independent locomotives for long and heavy trains. He regards a pressure of 1000 volts as feasible for ordinary work, but is of the opinion that for long distances conversion systems will have to be used. The views of Messrs. Houston & Kennelly are substantially the same as those of Professor Thomson, although they suggest that it would be preferable to work tentatively in the direction of the general line of development of the existing street-railway systems, rather than to attempt any radical innovation. Mr. Leonard is a believer in independent locomotives, and in transmission by the alternating current at high pressure, to be transformed on the locomotive to a continuous current. The discussion is an interesting one, and it is worthy of remark that there seems to be no substantial difference of opinion among the best expert authorities as to the general features of the successful electric railway of the future. In the following number of the same journal (Feb. 20) the symposium is continued. Professor W. A. Anthony points out that

one of the most important desiderata in electric-railway work is some efficient and trustworthy means of maintaining the motor at high efficiency under varying speeds. Mr. Leonard's plan, while providing for an economical variation of speed, labors under the disadvantage that it requires a 500-h. p. locomotive to be equipped with 1500 h. p. of electrical machinery. Professor Anthony thinks a potential of 1500 volts may be successfully used. With Professor S. H. Short, who follows him, he favors overhead conductors, and a frequent express service of light trains or motor cars. B. J. Arnold of Chicago, a prominent engineer, maintains practically the same views in respect to the arrangement of conductors, and the pressure to be used, and thinks that standard practice tends to the adoption of a locomotive having two or more axles, with a motor on each axle. This is substantially the design of the new locomotive now building for the Baltimore and Ohio R. R.

High Voltage Lamps for Central Stations.

IN an article in the London *Electrical Review* (January 11) Mr. G. L. Addenbrooke presents a strong plea for the adoption of high-voltage lamps for central station service. "How great a gain there is in distributing current at a higher voltage, and how much it simplifies the distribution problem, is not at first sight fully apparent, but they may really be said to progress as the cube of the voltage, up to, say, about 200 volts. "It is well within the mark"—says Mr. Addenbrooke—"to say that at 200 volts nine or ten times the area could be better served on the three-wire system from a single station than is now the case at 100 volts." Nothing, he thinks, really stands in the way of such a consummation but the existence in such numbers of the 8-candle lamp. A high-voltage lamp once secured, the whole central-station distribution problem becomes simplified, and an important factor in cheapening further the cost of supplying current is secured. A higher voltage would also get rid, without extra outlay, of the annoying loss of pressure on customers' premises, which frequently amounts to 2 per cent., and which makes a difference of 10 per cent. in the amount of light given by lamps near the mains and at distant points. A number of other incidental advantages to be gained by the change are pointed out, which added to those named make the argument of Mr. Addenbrooke stronger than might appear from this somewhat brief review of his well written paper.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Lighting.

*29153. Reducing the Cost of Electric Light. Nelson W. Perry (E Mag-April.) 3000 w.

*29178. The Amsterdam Electric Lighting Station. Ill. (E-Feb. 1.) 1400 w.

*29236. Three Central Electric Light Works. Halifax-Nottingham-Dewsbury. Ill. (E R L-Feb. 1.) 5200 w.

29290. An Electric Lighthouse. Ill. (E W-Feb. 16.) 1700 w.

29363. The Gas Engine and Electric Lighting. From an Electrician's Standpoint (B J C-Feb. 16.) 1200 w.

29399. The Model Arc Lighting Plant Recently Installed by the Mutual Electric Light and Power Company of Chicago. Ill. (E I-Feb.) 3200 w.

*29408. Wolverhampton Corporation Electricity Works. Ill. (E R L-Feb. 8.) 4000 w.

*29410. The Cannon Street Explosion. (Report.) (E R L-Feb. 8.) 5500 w.

29441. The Influence of the Carbons on the Candle Power of the Arc Light. Wilbur M. Stine (E W-Feb. 23.) 4000 w.

29443. Buffalo Electric Lighting Plants. Ill. Frank C. Perkins (E W-Feb. 23) 1000 w.

29446. What Shall We Pay our Firemen? J. B Calhoon (E W-Feb. 23.) 2000 w.

29451. The Great Brush Windmill Lighting Plant. Ill. (E N Y-Feb. 20) 800 w.

29452. Church Illumination. Ill. R. M. Bernard (E N Y-Feb. 20.) 4200 w.

29454. The Lighting of Cleveland (E N Y-Feb. 20.) 1400 w.

*29565. Dioptric Glass Shades and Holophane Globes. Ill. Andre Blondel (E R L-Feb 15.) 1600 w.

*29566. Some Points on the Working of Central Stations. J. Hardie McLean (E R L-Feb. 15.) 1500 w.

*29617. The Chemnitz Three-Phase Electric Lighting Station. Ill. (El-Feb. 15.) 2500 w.

We supply copies of these articles. See introductory.

*29637. The Electricity Works at Blackburn. Ill. (E E L-Feb. 1.) 4000 w.

*29638. Water-Power Installations for Electric Lighting. E. R. Dolby (E E L-Feb. 15.) 1200 w.

29649. "The Storage of Energy Essential to Economy of Working in Central Stations." Nelson W. Perry, with Discussion (E R N Y-Feb. 27.) 13500 w.

29650. "Correct Method of Protecting Electric Circuits." W. E. Harrington (E R N Y-Feb. 27.) 1600 w.

29671. The Monocyclic System. Ill. Louis Bell, with Editorial (E N Y-Feb. 27.) 6000 w.

29707. The Early History of Arc Lighting. Charles F. Brush (E W-March 2.) 1500 w.

29708. Large Arc Dynamos. Abstract of paper by C. N. Black, with Discussion (E W-March 2.) 2800 w.

29709. Arc Carbons and the Rating of Arc Lamps. L. B. Marks (E W-March 2.) 2800 w.

29723. Electric Lighting at Belfast. Alexander B. W. Kennedy (P A-March 1.) 800 w.

*29806. Electric Lighting Engines at the Neubad and Leopoldstadt Central Stations, Vienna. Ill. (E-Feb. 22.) 1600 w.

*29827. Double Refraction in Electric Rays. K. Mack (El-Feb. 22.) 3000 w.

29850. Decision in Bate Case—Incandescent Lamps Free (E E N Y-March 6.) 3300 w.

29926. A New Method of Measuring Illumination. Edwin J. Houston and A. E. Kennelly, with Discussion (E W-March 9.) 5000 w.

Power.

*29225. The Depoele Boring Machine in Hungary (C G-Feb. 1.) 1000 w.

29272. The Utilization of Water Power in California—The Folsom Sacramento Transmission. Ill. George Heli Guy (E E N Y-Feb. 13.) 1800 w.

29323. The Electric Motor in the Machine Shop. George Richmond. Read before A. S. M. E. (E R-Feb. 16.) 2000 w.

29444. Coal Consumption in Central Stations. E. A. Merrill (E W-Feb. 23.) 2000 w.

29450. Central Station Economy. Editorial (E N Y-Feb. 20.) 1400 w.

†29487. Generating Electricity by Windmills. I. N. Lewis (I Eng-Jan. 19.) 4300 w.

29536. About Dynamos—Their Practical Care and Management. H. Buck (B J C-Feb. 23.) 1000 w.

*29639. Reversible Regenerative Armatures and Short Air-Space Dynamos. W. B. Sayres, with Discussion (E E L-Feb. 15.) 4600 w.

29700. Electric Motors for Driving Machine Tools. Condensed Letter From M. Melotte (E N-Feb. 28.) 500 w.

29703. The Stanley Electric Manufacturing Company and its Two-Phase Work. Ill. (E E N Y-Feb. 27.) 3500 w.

*29769. Distribution of Electrical Energy in Mills. Ill. (M W-Feb. 22.) 2500 w.

29873. Municipal Ownership of Niagara Power Distribution for Buffalo. Frank C. Perkins (E N Y-March 6.) 2000 w.

29888. Storage Battery Plant for Electric Light and Railway Work at Merrill, Wis. Ill. (E R N Y-March 6.) 1300 w.

†29894. Action of a Single-Phase Synchronous Motor. Frederick Bedell and Harris J. Ryan (J F I-March.) 6000 w.

29946. Storage Battery Plant for Light and Railway. Herbert Condict (E M J-March 9.) 1800 w.

Telephony and Telegraphy.

29270. The Telephone Station in the Main Post-Office at Leipzig. Ill. (Sc A S-Feb. 16.) 500 w.

29278. The Latest Long Distance Telephone Transmitter. Ill. (Sc A-Feb. 16.) 1200 w.

29279. The Blake Transmitter. Ill. (Sc A-Feb. 16.) 2000 w.

29301. The New Telephone System of Paris. Ill. E. Hospitalier (E A-Feb 16.) 2500 w.

29310. Modern Telegraphy—Rapid Printing Telegraphy. Ill. (I Age-Feb.) 2000 w.

29360. The Pneumatic Telegraphs of Paris. Samuel E. Morss (A A-Feb. 16.) 3800 w.

29390. The Carbonnelle Microphone for Long Distance Telephony. Ill. From L'Industrie Electrique (E R N Y-Feb. 20.) 1200 w.

29392. Telephone Cables With Dry Air Circulation. A. Barbaret (E R N Y-Feb. 20.) 1500 w.

29453. Pictorial Telegraphy. Ill. Nelson W. Perry (E N Y-Feb. 20.) 1300 w.

29520. Specifications for Electrical Cables for Baltimore Subways. Ill. (E N-Feb. 21.) 3000 w.

29875. Royal E. House and the Early Telegraph. Ill. Franklin Leonard Pope (E E N Y-March 6.) 1000 w.

Miscellany.

*29171. Electric Discharge Through Gases. Ill. J. J. Thomson (E E L-Feb. 1.) 3500 w.

*29215. Some Continental Electric Supply Stations. G. F. Metzger (El-Feb. 1.) 2800 w.

*29216. Fleuriais' Electric Log. Ill. (El-Feb. 1.) 1500 w.

*29218. "Labor Saving" Apparatus as an Instrument of Education. J. A. Fleming (El-Feb. 1.) 1400 w.

*29235. Toepler High Frequency Experiments (E R L-Feb. 1.) 1400 w.

29267. On a Proposed Modification of the Generally Accepted Temperature Co-efficient of Resistance for Copper Wires. A. E. Kennelly and Reginald A. Fessenden (E R N Y-Feb. 13.) 500 w.

29269. Results of the Elihu Thomson Competition. B. Abdank-Abakanowicz (E N Y-Feb. 13.) 2000 w.

29271. Protection From Lightning. Alexander McAdie (Sc A S-Feb. 16.) 7000 w.

29273. Electrical Education. Edgar Kidwell (E E N Y-Feb. 13.) 4200 w.

29288. Does Execution by Electricity, as Practiced in New York State, Produce Instantaneous, Painless and Absolute Death? Observations Made at the Execution of David Hampton, at Sing Sing, Jan 28, 1895. A. E. Kennelly and Augustin H. Goelet (E W–Feb. 16.) 1300 w.

29291 The Effect of Armature Current on Magnetic Leakage in Dynamos and Motors. Harry D. Frisbee and Alexander Stratton (E W–Feb. 16.) 2500 w.

29318. The Schafer-Heinemann Accumulator. A. M. Gibson (E M J–Feb. 16.) 2500 w.

*29335. Juvenile Lectures on Electricity. (Abstract.) J. A. Fleming (Pl D–Feb.) 1700 w.

29389. On Experiments with Tesla Currents. F. Himstedt in "Weidmann's Annalen." (E R N Y–Feb. 20.) 800 w.

29391. Primary Battery Testing.—Methods and Apparatus of the German Telegraph Department for Finding Commercial Efficiency. V. M. Berthold (E R N Y–Feb 20.) 1000 w.

29401. Electricity for Mechanics. Ill. George Cutter (E I–Feb.) 1300 w.

29438. A New Method for Deducing the Expression for Electromagnetic Force. Cary T. Hutchinson and E. R. Carichoff (E W–Feb. 23.) 500 w.

29442. The Electrical Transformer. Ill. Caryl D. Haskins (E W–Feb. 23.) 3400 w.

29445. Iron-Armored Conduit Construction. Ill. George T. Hanchett (E W–Feb. 23.) 1000 w.

†29596. Notes on Recent Electrical Engineering Developments in France and England. H. Ward Leonard (T A I E E–Feb.) 6800 w.

*29619. Transformer Chambers. Ill. (El–Feb. 15.) 600 w.

*29623. The Influence of Temperature on the Magnetization of Iron and Other Magnetic Substances. Henry Wilde (C G–Feb. 15.) 1300 w.

29702. The Leonard Electrically Heated Apparatus. Ill. H. Ward Leonard (E E N Y–Feb. 27.) 1300 w.

*29797. Experiment for the Demonstration of Thermo-Electric Currents. Ill. Ch. Ed. Guillaume (E R L–Feb. 22.) 500 w.

29874. The Electric Annealing of Armor Plate. Elihu Thomson (E E N Y–March 6.) 1100 w.

†29893. The Application of Electricity to the Bleaching of Textile Fabrics. Ill. Louis J. Matos (J F I–March.) 5400 w.

29925. A Straight Line Accumulator Characteristic. Carl Hering (E W–March 9.) 600 w.

29945. Action of the Electric Current on Fused Sulphurets. (Abstract.) Jules Garnier (E M J–March 9.) 600 w.

Serials.

9531. Suggestions for Metering Devices. Ill. S. D. Mott (E W–Began Jan. 14, 1893—7 parts to date—15 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (E W–Began May 19—31 parts to date—15 cts. each).

23866. Electro-dynamic Machinery. Ill. Edwin J. Houson and A. E. Kennelly (E W–Began July 21—26 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A–Began Aug. 25—22 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Ill. Howard Pentland and Alfred H. Gibbings (E L–Began Oct. 5—21 parts to date—30 cts. each).

26592. Electrical Power Transmission. Louis Bell (E W–Began Nov. 10—15 parts to date—15 cts. each).

27371 The Electric Light. Henry Stooke (I C E–Began Nov. 23—14 parts to date—30 cts. each).

27704. Some Hints on the Building of Electric Plants. Charles G. Armstrong (E I–Began Dec.—3 parts to date—15 cts. each).

27855. Method of Determining the Efficiency of Dynamos and Motors. J. Reginald Ashworth (E P–Began Dec.—Ended Feb.—3 parts—30 cts. each).

28759. The Electric Arc. Hertha Ayrton (El–Began Jan. 18—4 parts to date—30 cts. each).

29132. The Mechanics of Electro-Magnetism. Ill. Wilbur M. Stine (E A–Began Feb. 9—Ended Feb. 16—2 parts—15 cts. each).

29156. Technical Telegraphy Papers. James Bell and S. Wilson (E L–Began Feb. 1—4 parts to date—30 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. C. H. Yeaman (E L–Began Feb. 1—4 parts to date—30 cts. each).

29159 Notes on Search Lights. Ill. J. Watts (E L–Began Feb. 1—3 parts to date—30 cts. each).

29287. On Magnetic Potential. Frederick Bedell (E W–Began Feb. 16—1 part to date—15 cts).

29289. On Potential. Wilbur M. Stine (E W–Began Feb. 16—2 parts to date—15 cts. each).

29615. On the Delineation of Alternating Current Curves When the Alternator Is Not Accessible. Ill. J. A. Fleming (El–Began Feb. 15—2 parts to date—30 cts. each).

29616. Core Losses in Alternate-Current Transformers. Ernest Wilson (El–Began Feb. 15—Ended Feb. 22—2 parts—30 cts. each).

29640. The Application of the Electric System of Welding to Machinery and Boiler Repairs. Ill. Henry Foster (E E L–Began Feb. 15—Ended Feb. 22—2 parts—30 cts. each).

29798. On Slow Changes in the Magnetic Permeability of Iron. William M. Mordey (E R L–Began Feb. 22—1 part to date—30 cts).

29829. Propagation of Magnetization of Iron as Affected by the Electric Currents in the Iron. Ill. J. Hopkinson and E. Wilson (El–Began Feb 22—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY

Freeland.

A GROUP of papers in the *Fortnightly Review* is entitled "Side Lights on Socialism." Among these a paper entitled "Experiments in Colonization," by Edward Salmon, gives an account of a scheme based on principles enunciated by Dr. Theodor Hertzka, an Austrian economic prophet not without honor in his own country, whose teachings are gaining attention throughout Europe. Dr. Hertzka is the author of a book entitled "Freeland: A Social Anticipation," which has been widely circulated in the original, and has been recently translated into English by Mr. Arthur Ransom. The burden of the book is the outlining of a social organization, in which "economic justice" shall be attained on lines of individualism rather than communism.

"Freeland is to be the natural product of evolution. Dr. Hertzka does not denounce either past or present, but has come to the conclusion that civilization is moving towards an economic state, as different from the present as the present is from the remote past. Man in early days took to fighting his neighbor, and, if he vanquished him, ate him; cannibalism gave place to serfdom, when the victor came to understand that his captured enemies could be utilized to his profit. By the efforts of his people the master obtained wealth and leisure—two necessaries of discovery and scientific progress. Hence, with those who condemn the system of landlordism and capitalism, as it has obtained up to the present, Dr. Hertzka has no sympathy. Without that system society would not have advanced—at any rate as rapidly and effectually as it has done—beyond the barbaric stage. A philosopher who takes that view may be trusted to lend no ear to those who would unconditionally confiscate property. He does not regard all wealth, and all exploitation of other people's labor, as robbery. 'Exploitation,' he says, 'is robbery only in an economic, not in a judicial sense; it was not merely considered to be permissible, it was permissible. . . The appropriation of other men's earnings, which in an economic sense we are compelled, and rightly so, to call robbery, was, let us not forget, the necessary condition of any really productive, highly organized labor, so long as the workers were not able to freely organize and discipline themselves. Economic robbery, the relation of master held by the few towards the many, constituted an effective economic service that had the strongest right to claim the profit of other men's labor, which was in fact rendered profitable by it. Subsequently to confiscate the thus acquired compensation for the services rendered, because such services had become superfluous, or indeed detrimental, would in truth be robbery, not merely in an economic sense, but in a legal sense,—an offence against the principles of economic justice.' That is a standpoint which will please neither uncompromising Tory nor determined Socialist, but it is one which may conceivably acquire strength in proportion as it is fully understood. Wholly consistent with the foregoing are the Freelander's views on wealth. He does not regard wealth as a wicked and wrongful possession because it is something which others have not. He regards with stern disapproval only that wealth which is due to exploitation. Herein we find a note struck which has no likeness in any other advanced economic system. All attempts at the realization of the Socialist propaganda have failed, or are considered by Dr. Hertzka to have failed, because they have aimed at equality, not of wealth, but of poverty, at levelling down instead of levelling up,—a process which carries with it stagnation and decay."

At first all this reads like many of those economic generalizations which have been put forth in profusion during the last decade. But, closely studied, one sees that it is an extension into ethics and econom-

ics of the old princple that *ex post facto* legislation is injustice. The leading points of Dr. Hertzka's "Freeland" scheme are as follows: "At the beginning of March last the Freeland Pioneers set sail from Europe to Africa to discover a site for a colony which was to be brought into existence in response to Dr. Hertzka's teaching. . . . Difficulties, physical and moral, prevented the pioneers from reaching the spot in Africa whither they were bound. The pioneer enterprise proved a failure, and Freeland has yet to be located." This brief but comprehensive history does not, however, justify the conclusion that the experiment will never be tried. Mr. Salmon thinks the scheme has something to recommend it and hopes it may yet have a trial; and it appears that there is a greater or less following throughout Europe of like mind.

The first prominent feature of the scheme—individualism as opposed to communism—has been mentioned. "There is to be no monotonous uniformity of reward for widely-varied services, and no indifference to superior claims." Men are to be paid according to value of services rendered, and may amass personal property as they can find means and opportunity to do so. But there is to be no private ownership of land (here the scheme runs parallel with the Single Tax doctrine), and no capitalism, because interest on capital is to be abolished, interest being, in Dr. Hertzka's opinion, the parent of capitalism. Under these favoring conditions wealth is expected to be generally diffused, and it is anticipated that work will be provided for every able-bodied man, while there will be no lack of asylum for the halt, the aged, and the very young. Unmarried women will have adequate provision made for them by the State. Freeland will be a paradise for spinsters, but it is not expected that many women will remain unmarried on that account. Women's work is to be "the education of children and the care of the sick and the infirm." These are the salient points of the scheme. Unlike Mr. Salmon, we do not hope it will reach the experimental stage. The moral difficulties met with in the pioneer effort to select a site will become far more formidable if a site shall ever be found and occupied by a colony made up of such human elements as would be available for colonization; and the inevitable failure, with its attendant sorrow and suffering, would only be a repetition of a too oft-told tale.

Compulsory Arbitration.

NOTWITHSTANDING the fact that compulsory arbitration has been shown to be in its very essence an impracticable scheme,—a method of settling disputes which must in the nature of things leave dissatisfied one or both sides to a controversy between employers and employed,—there are yet many who cannot see the inherent weakness of the system, and who advocate its adoption. A discussion of compulsory arbitration as related to the settlement of the frequently-recurring labor troubles in the mining districts of the United States, more particularly in the coal-mining regions of Pennsylvania, communicated by an American correspondent, is printed anonymously in *The Colliery Guardian*. It is stated that the success of the system of voluntary arbitration in the English mining districts was used as an argument in urging the Pennsylvania coal and iron industries to adopt the method. But neither in Pennsylvania or any other State have proposals on these lines been taken up with any great amount of heartiness; and masters and workmen now find themselves, as the result of their inability to settle their disputes without serious loss and sometimes danger to the general community, face to face with a suggestion that arbitration should be made compulsory by law. The matter was prominently referred to at the recent annual convention of the American Federation of Labor, held at Denver, Colorado, and again at the Industrial Arbitration Congress held lately in Chicago. "Mr. Carroll D. Wright, government commissioner, is the main author of the compulsory arbitration scheme, which, before long, seems likely to be brought before the congress. The exact details of the scheme are not before us, but among the general public, who would

be glad to be relieved, at almost any cost, of the tremendous hindrance to business caused by strikes in the United States, particularly when the strikers get hold of the railroads, the suggested new legislation is received with favor. It is, however, a very striking circumstance that among the parties most concerned—*viz.*, the employers and workmen themselves—the idea is received with scant courtesy. In the Pennsylvania mining districts this opposition is very strong, neither the miners nor coal owners seeming willing to accept State interference. At the Industrial Congress in Chicago the new departure was stoutly opposed by the president of the Amalgamated Association of Iron and Steel Workers, the president of the American Federation of Labor, and by our working-class leaders."

In some of the recent disputes in these districts it has been found that the weight of opinion is against compulsory settlements.

"The men declare that the imposition of such conditions as are proposed by the State would be 'tantamount to slavery'; while the masters profess that under such schemes 'the government always forces the employer to yield, but never the employee.' The probabilities of the scheme getting through the congress, therefore, do not seem very strong. It is argued that, if an employer is compelled to pay wages which he is not willing to pay, this is confiscation, and that, if an employer is unwilling to keep his mines open or his works running at a certain profit, the government could not seize his works, since this would mean robbery. Each side seems convinced (at least they profess) that the only acceptable plan for the prevention of coal and iron trade and railway labor difficulties is to establish voluntary arbitration and conciliation, and to depend upon public sentiment to enforce its verdict. It is admitted that the State has the right, in cases of danger of an industrial conflict, to investigate concerning the causes, and, if possible, seek to prevent the stoppage of industry or commerce. The claim of the State, however, to compel masters or workmen to continue working under terms that neither, in the exercise of their independent judgment, are willing to accept, is being stoutly combated. Unfortunately, however, as matter of fact, arbitration, whether voluntary or compulsory, in labor disputes seems to lack any amount of enthusiasm in the Pennsylvania or any other of the American coalfields."

Last year an agreement was entered into between the Pittsburg coal owners and their men, comprising a uniform wages scale, and providing for arbitration in case of any deviation from the scale. A reduction threatened on one side led to threats of a strike on the other, and no serious attempt to arbitrate has been made. At the close of the strike in Massillon an arbitration resulted in a decision which the men refused to accept, declaring that the decision was not according to the evidence. All this indicates that arbitration, especially compulsory arbitration, is not popular with either employers or the employed on this side of the Atlantic.

Altruria.

AN organization taking the name of the Altruria Association was founded in the spring of 1894. Mr. Edward Payne, in *The American Magazine of Civics*, gives an account of this society and its object and methods, and says that it has so far met with peculiar public favor in California and is beginning to attract attention throughout the country. This association has located its headquarters near Santa Rosa, Sonoma County, California.

"The organization is a fraternal order. Brotherhood is the corner-stone. The motive is mutual good-will. The merely selfish point of view is condemned. The service of all by each, and the service of each by all, is the balanced and comprehensive principle. And this upon the ground that man owes just this to man."

Money paid into its treasury is "not an investment upon which interest or dividends will be paid." The nominal membership fee is $50. It is explained that even this is not an investment, but is exacted because at present the society cannot proceed at all without it; and the abolition

of any initiation fee whatever is contemplated at some future time, when the association shall find itself able "to receive people on the basis of their personal fitness, accepting what they can and will bestow voluntarily on the cause."

To establish an intimate relation between actual workers in the colony and outside sympathizers a series of councils has been instituted. Several subordinate councils already exist in various cities of California. There are recruiting agencies to the colony forces, and also educational institutions in their several communities. The members are not pledged to go to the colony, but may do so on certain conditions. If they do go, they enter Altruria Council No. 1, which is yet a subordinate and probationary council, on the working grounds. In this relation they remain for six months, sharing the work of the colony and all its privileges, except that they have no voice in the management of affairs. At the end of this period they may honorably withdraw, or may await the judgment of the Grand Council as to their fitness to remain. When received into the Grand Council, they are members for life, if they abide by the principles and regulations of the institution.

The aims of the Altruria Association are both economic and social. "The greater thought is to secure and maintain wholesome and happy relations in every respect, to make social life strong, beautiful, and sweet, and individual experience free, joyous, and noble." To this end all members are pledged to maintain a high standard of personal, domestic, and social morality. The intention to do active missionary work is announced, and it is stated that, as the society prospers, a large portion of its surplus will be set aside for the establishment and fostering of other settlements. These also are expected to become active propagandists, and thus it is hoped to prepare for the coming of "the real commonwealth, based on commonweal, that is to be." Various industries will be established. Each member, male or female, has an equal voice in selecting officers. Children, the sick, and the aged are to be cared for by an allowance from the common stock.

One seeks in vain in this exposition for any new principle of association on which to base an expectation of permanency. Similar organizations with the same ends and methods have time after time been formed, have lived out a brief term of anxious existence, and then have failed utterly. No such society has ever yet been able to realize its ideals; and, until human nature shall have been wholly regenerated, an association of this kind must inevitably fail, because success means renunciation of self on the part of each member, and individual devotion to the good of the whole. The nature of mankind has not yet reached this stage of evolution.

Desirability of an International Money Clearing-House.

THE ENGINEERING AND MINING JOURNAL (Feb. 16), under the title "The Gold Movement for Four Years," in a carefully-prepared table compares exportations of gold from the United States in excess of imports with the output from our gold mines, and finds an opportunity to introduce an argument for an international clearing-house as a measure of commercial economy. In 1891 the loss in gold over imports and production was $714,688; in 1892 there was a loss of $25,365,291; in 1893 we gained $29,477,297; and in 1894 we again lost $39,488,915. This does not include gold carried out of the country in a private way, of which the amount can only be guessed at, but which is certainly not an insignificant sum. The table, compiled from the report of the bureau of statistics of the United States treasury department, thus shows an aggregate loss for the 4 years of upwards of one-fourth the actual production of gold for the same time. Our contemporary estimates that the total taken out of the country privately would probably double the reduction indicated in the tabulated statistics. The Baring failure is thought to have accelererated this movement, which began in 1891. In 1893 the tide seemed to have turned in favor of the United States, only to be followed in 1894 by a larger exportation than ever before. An examination of this gold movement in all its phases leads to the

conclusion that, "until our treasury is permanently removed from the banking business, and the conditions of trade cease to be dependent upon the action of the government, we will always be exposed to crises similar to that from which we are just escaping." With reference to the proposed international monetary clearing-house, we quote the following:

"The disturbance of trade by gold exports, the currency panic through which we passed last year, and that from which we have so narrowly escaped, would have been entirely averted,—or rather would not have been possible,—had the international monetary clearing-house system been in operation. The regulation of foreign exchanges and the prevention of such movements as we have recorded above, which would be accomplished by that system, would, we believe, in a few years produce so great an improvement that the commercial world would not only accept the system, but wonder why it had not been carried into practice long before. There is another point which is worth consideration. During the four years given in the table above the total movement of the yellow metal to and from this country amounted to over $493,000,000. The actual cost of handling and shipping this amount, with the other charges,—such as freight, interest, insurance, etc.,—amounted to a considerable sum, probably much more than would have been sufficient to pay all the necessary expenses of the international monetary clearing-house, so that the operations of such a commission would have shown an actual economy in the expenditure of money, in addition to the almost incalculable saving from its benefits to business generally."

Industrial Conditions in Central Europe.

THE over-stimulation of the manufacturing industries, which, according to *The Age of Steel* (Feb. 16), is the cause of industrial troubles in the United States, has, in the opinion of that journal, brought about the same state of things in Central Europe. But it is claimed that these conditions are even more pronounced in Europe than in America. "The policy of the countries of Central Europe has been, particularly for the past twenty years or more, to inflate their manufacturing industries indefinitely, instead of trying to maintain a healthy equilibrium between the agricultural and manufacturing interests, each as a national life force. Several of these Central Europe States have an established system of economic jugglery, whereby labor and industry are taxed for an export bounty on manufactures. The result has been to add largely to a previous adequate—or, perhaps, superabundant—supply of labor at manufacturing centers. As in this country, the ambitious breadwinners have turned their eyes and feet toward the great cities. The movement has glutted the urban labor market, and caused wages to fall to almost, if not quite the point of bare existence for the workers. Labor-saving machinery has aggravated the evil by increasing the number of idle, whose services are both statistically and actually available at cheap rates. In such circumstances, the manufacturing industries have made headway,—more rapidly so, when reasonably intelligent labor can be had for a song, comparatively speaking; and back of this order of things looking to the lowest practicable standard of living for the worker are huge military establishments for shooting holes through strikes and revolutions with equal impartiality and celerity."

Germany is noted for its low wages, particularly in the iron industries. These low wages and attendant industrial conditions also prevail in Belgium, and in the Grand Duchy of Luxembourg. "Wages in and about the mines in the Grand Duchy have increased in the following itemized way: laborers, from 54 cents a day in 1871, to 68 cents in 1894; surface miners, from 64 to 65 cents; miners in gallery, decrease from $1.10 to $1; drivers in gallery, unchanged at 80 cents; sorters, from 60 to 77 cents; rail-layers, from 60 to 81 cents; smiths and wheelwrights, from 75 to 87 cents. At the steel works, rolling mills, and blast furnaces of the Grand Duchy wages are correspondingly low, and, from the American standpoint, disproportionately so. The foreman of a steel works, for example,

must thrive on $60 to $70 a month, and the assistant foreman on $1.18 a day. Converter hands, founders, basin hands, and converter machinists are each classified as first, second, and third, and are paid accordingly. Extreme wages range, for converter hands, from 73 cents to $1 07 a day; for founders, from 76 cents to $1.18; for basin hands, from 70 cents to $1.03 for the first-class. Ladlers receive 84 cents a day, ingot cleaners 52 cents, machinists 65 to 80 cents, cupola hands 60 cents. Rolling-mill and blast-furnace employees are paid in about the same proportion." The cost of clothing and rent is somewhat less than in the United States, but food costs as much or more than in this country, as will be seen by the following prices. Coal costs $7 per ton; eggs, 21 cents per dozen; rye flour, 3 cents per lb.; wheat flour, 5 cents per lb.; sugar, 8 cents per lb.; butter, 25 cents per lb.; beef, 19 cents per lb.; veal and mutton, 16 cents per lb.; fresh pork, 20 cents per lb.; and smoked pork, 23 cents per lb.

Profit-Sharing.

IN discussing editorially the subject of profit-sharing, and taking as a text a paper read by Mr. John L. Ketcham before the Indianapolis Literary Club, *The Iron Age* takes the ground that profit sharing is not a panacea for existing labor troubles, and that, while it would be admittedly correct in theory were all the lazy, shiftless, suspicious, and discontented eliminated, as long as average human nature remains what it is the system can never be made to work according to theory, and in the large majority of cases it is certain to fail of its object. "The first instances in which it is successful, or apparently so, do not prove that other employers will find it beneficial to them. Such a scheme will flourish if all the conditions are favorable, and especially if the originator is gifted with a peculiar genius for philanthropic work, but not if it is entered upon as a cold, mechanical, mathematical business proposition. As well might the success of certain communities holding property in common be cited as proving that the true way of solving the problem of life is to form such communities everywhere. Innumerable unsuccessful efforts have been made to establish other communities, which were failures because the organizing talent was lacking. Other requirements are necessary than executive ability, and these requirements are not common."

Successful Profit Sharing.

As opposed to the opinion above expressed, two examples of alleged success in profit sharing are cited by F. W. Blackmar in *The Forum* for March. The establishments named are the soap and candle manufactory of Proctor & Gamble at Ivorydale, Ohio, and the N. O. Nelson Manufacturing Company, manufacturers of machinery near St. Louis, Mo. The first-named establishment is large, employing a considerable proportion of unskilled laborers, and the average wages are $10 per week. The plan now in operation is the payment of 12 per cent. dividends on the common stock, provided this dividend is earned and after paying each member of the firm a salary of $4000. Fully 98 per cent. of the laborers are said to now participate in the profits, beginning to share after having been in the employ of the company for 3 months. If an employee quits work or is discharged before 3 months of service he does not share. Employees are encouraged to acquire portions of the capital stock. A pension fund is created by setting aside $500 annually for this purpose.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

25155. Credit and Trade (B M–Feb.) 1000 w.

29169. A Lesson of the Present Depression in the Iron Market. Charles Catlett (A M & I W–Feb. 8.) 900 w.

*29172. Revolutionary Legislation. T. W. Graham (Mill–Jan.) 1800 w.

*29226. Compulsory Arbitration in American Mining Districts. Anon. (C G–Feb. 1.) 1000 w.

We supply copies of these articles. See introductory.

29187. The Brooklyn Strike from a Financial Point of View. From the Brooklyn Eagle (S R G-Feb. 9.) 2000 w.

29265. Labor Arbitration in France. Charles W. Whiley, Jr. (R R-Feb. 9.) 1200 w.

29276. Prevention of Railroad Strikes. Recommendations of the New York State Board of Arbitration (Ir Age-Feb. 14) 400 w.

†29282. Sidelights on Socialism. I. Belgian Socialism. H. G. Keene. II. Experiments by Colonization. Edward Salmon. III. Woman and Socialism. Karl Knödel (F R-Feb.) 12500 w.

†29283. Is Bimetalism a Delusion. Edward Tuck (N C-Feb.) 2800 w.

†29284. The Rural Revolution. Richard Heath (C R-Feb.) 7500 w.

†29285. The Evolution of Cities. Elisée Reclus (C R-Feb.) 10400 w.

†29286. The Voluntary School. James M. Wilson (C R-Feb.) 8400 w.

29317. The Gold Movement for Four Years. Editorial (E M J-Feb. 16.) 1100 w.

29372. An Easy Lesson.—True Money—What it Is. How to Make It Plenty. Edward Atkinson (F-Feb. 15) 2800 w.

29380. The Settlement of Differences. Frederick E. Goodrich (Boston Commonwealth-Feb. 16.) 1400 w.

29398. Central Europe Industrial and Labor Conditions. Editorial (A S-Feb. 16.) 800 w.

*29425. Railways and Voluntary Schools. Editorial (Ry T-Feb. 9.) 1200 w.

*29470. Russian Armenia and the Prospect for British Trade Therein. Anatolius Vladimirovich Markoff, with Discussion (J S A-Feb. 8.) 6800 w.

*29471. An Introduction to the Labor Question in the Colonies, America and Foreign Countries. Geoffrey Drage, with Discussion (J S A-Feb. 8) 18800 w.

*29533. New Unionism Reviewed (J G L-Feb. 12.) 2200 w.

*29554. Shall We Look Backward or Forward in Dealing with the Criminal? Henry Smith Williams (A M C-March.) 5700 w.

*29555. Money. James A. Quarles (A M C-March.) 8500 w.

*29556. Socialism and a Municipal Commonwealth. Lemuel C. Barnes (A M C-March.) 2700 w.

*29557. Do the Victors Own the Spoils? Ellis Biddle Reeves (A M C-March.) 2500 w.

*29558. Energy of Legislation. Edward P. Powell (A M C-March.) 2800 w.

*29559. Canada's Future as Seen by Canadians. Helen Gregory-Flesher (A M C-March.) 4000 w.

*29560. Are American Homes Decreasing? A Reply to J. A. Collins. Gilbert L. Eberhart (A M C-March.) 2800 w.

*29561. Education of the Farmer. Samuel James Logan (A M C-March.) 3000 w.

*29562. The Single Tax—A Reply to Arthur Kitson. R. W. Joslyn (A M C-March.) 2800 w.

*29563. Shall We Nationalize the Liquor Traffic? Mrs. A. L. Cornwall (A M C-March.) 2000 w.

*29633. Labor Questions. Editorial (E-Feb. 15.) 2000 w.

29648. The Public and Street Railway Strikes. William J. Richardson (S R G-Feb. 23.) 2200 w.

29660.—$1. Elected or Appointed Officials? A Canadian Question. J. G. Bourinot (An A A-March.) 10800 w.

29662.—$1. Terminology and the Sociological Conference. H. H. Powers. (An A A-March.) 4200 w.

29663.—$1. A Neglected Socialist. F. C. Clark (An A A-March.) 7500 w.

29664.—$1. The Organic Concept of Society. A. W. Small (An A A-March.) 3000 w.

29665.—$1. Sociology and the Abstract Sciences—The Origin of the Social Feelings. F. H. Giddings (An A A-March.) 3000 w.

†29740. A New Departure in English Taxation. Lord Playfair (N A R-March.) 2800 w.

†29741. The Future of Silver. R. P. Bland (N A R-March.) 2800 w.

†29742. How to Prevent Strikes and Lockouts. Stockton Bates (N A R-March.) 1700 w.

29743. Society and Strikes (S Ec-March.) 1500 w.

29744. The Free Coinage of Bonds (S Ec-March) 1800 w.

29745. The Single Tax Superstition (S Ec-March.) 3500 w.

*29752. Tariff Changes and Customs Regulations. Russia, Sweden, Germany, Switzerland, France, Spain, Bulgaria, United States, Mexico, Brazil, Argentine Republic, Uruguay, Gambia, Mauritius (B T J-Feb.) 5000 w.

*29807. Prison Labor. Editorial (E-Feb. 22.) 3200 w.

*29909. Altruria. Edward B. Payne (A M C-Feb.) 1200 w.

*29910. The Business World vs. the Politicians. J. H. Eckels (F-March.) 2500 w.

*29911. Our Blundering Foreign Policy. H. C. Lodge (F-March.) 4000 w.

*29912. What Would I Do with the Tariff if I Were Czar? Andrew Carnegie (F-March.) 4000 w.

*29913. Is the Income Tax Constitutional and Just? E. R. A. Seligman (F-March.) 3500 w.

*29914. Two Examples of Successful Profit-Sharing. F. W. Blackmar (F-March.) 4500 w.

*29916. The Tenement the Real Problem of Civilization. Jacob A. Riis (F-March.) 4800 w.

Serials.

28842. The Social Discontent. Henry Holt (F-Began Feb.—2 parts to date—30 cts. each).

29766. An Armory Against Socialism—Account of a Work by Dr. Flint (J G L-Began Feb. 19—Ended Feb. 26—2 parts—30 cts. each).

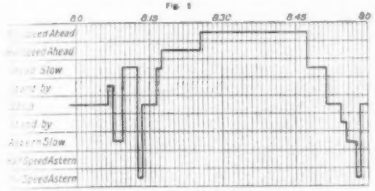
We supply copies of these articles. See introductory.

MARINE ENGINEERING

The Thompson & Marsden Recorder.

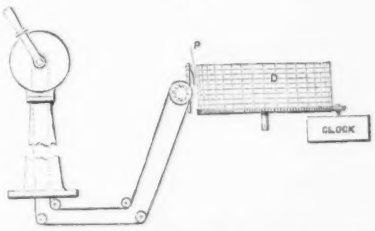
THIS ingenious, yet simple, device supplies means for settling disputes of a kind likely to occur in endeavoring to fix responsibility for collisions of ships. After these collisions, while officers who were on the bridge assert one thing, those who were on duty below are as apt to say another, each striving to shift the responsibility from themselves to others. *The Engineer* (Feb. 1), from which the illustrations given herewith have been reproduced, in commenting upon the necessity for a device of this kind, says: "We do

Fig. 1



not mean to say that in all cases there has been wanton lying, but we do mean to say that it would be very difficult for the most conscientious and scrupulous on both sides to agree on such a matter. Take a case where there is a man above and another below, each conscientiously jotting down the orders with their times, as they are delivered, on a slate, the clocks working together exactly,—unheard-of conditions,—we doubt if in ninety-nine cases out of a hundred in actual every-day practice the two tables thus compiled would correspond." It is said that the recorder illustrated in the engravings has been subjected to such long and severe tests that no doubt remains as to the claims made for its performance. "It records on a sheet of paper the time and duration of every order in such a way as to leave no possible doubt. It chiefly consists of a recording drum, on which a metallic pencil, actuated by the telegraph lever, presses, the movement of the pencil being parallel to the axis of the drum, which, for convenience's sake, is vertical. The drum revolves once in 12 hours, and each card lasts for that time, beginning at 8 A. M. Fig. 1 shows the divisions on the card of the hour into quarters, which are again subdivided into minutes. Let us take the instance of a ship getting under weigh in the forenoon watch. From the pencil path in Fig. 1 it is clear that the engineers got word to stand by at 6½ minutes past eight, and a minute later got the order for 'astern slow,' which lasted for two minutes, when they had to reverse and go ahead, and so on. The card thus tells its own tale, the vertical lines giving the orders, and the horizontal lines showing how long each order was in force without alteration. Thus any one can read the card at a glance. Fig. 2 shows the principle of the mechanism, the telegraph lever and pencil being at their respective positions for 'stand by ahead.' It will be seen from Fig. 2 that the pencil is held by a rack, which is raised or lowered, as the case may be, by a pinion receiving its motion from

Fig. 2



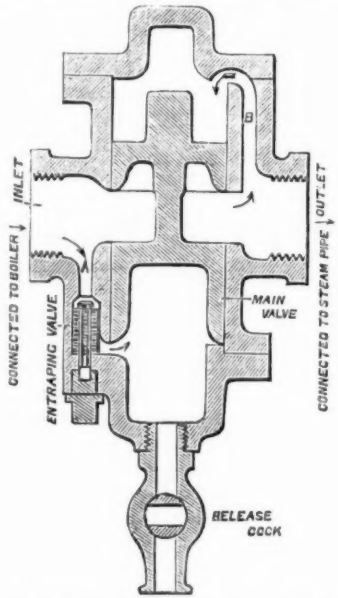
either the telegraph spindle or from the chains to the engine-room, which amounts to the same thing. Of course the recorder can be put anywhere on the bridge, or in the captain's cabin, or even in the engine-room, and it in no way interferes with the action of the indicators at present in ordinary use, being merely an accessory to them in the form of a silent and accurate witness and recorder of their every movement. It

should be understood that the path delineated by the pencil in Fig. 1 is caused by the use of the telegraph lever when simply moved and not swung, as it most often is, to its extreme position on each side in order to give a louder and more decided ring on the bell, so that each order would be shown by what would really be a zig-zag, the angles of which would be so acute as to be invisible, the result being a thick, almost vertical line the entire height of the card."

It seems that the use of this device ought to obviate completely any such conflict of testimony as has hitherto obscured the real causes of collisions, and enable authorities to determine with certainty whether any fault was committed, and, if so, who committed it.

Steam-Pipe Safety-Valves.

THE inventor of this device is a citizen of Dublin. In our February number we noticed in this department the dangers attending explosions of steam pipes at sea, and some of the means proposed for their prevention. The device under present consideration was illustrated and described in *The Engineer* (London, Feb. 1), from which we have reproduced the engraving. The invention is intended to prevent the outrush of steam and loss of life which take place when a steam-pipe bursts in an engine room. "The principle involved is that so long as the steam flows at a moderate speed the valve will remain open. If the pipe bursts, the violent outrush closes the valve on the boiler at once. The valve is connected as close to the boiler as possible, and steam turned on, filling every part of it with steam of equal pressure; and, as the valves are of equal areas, there can be no movement, as the steam fills the space below the small valve—on the top—or between the heads of the double-headed valve and on the top; in this position every part is in equilibrium, and the weight of the valves keeps them down. In this position there is a full straight way from the inlet to the outlet side of the valve, and, as the opening through the valve is arranged to be equal in area to the pipe, there cannot be any obstruction. Should a pipe burst, or any other accident occur to suddenly release the steam and permit it to flow into the atmosphere, all the conditions are changed. This release of steam reduces the pressure above the small valve, which closes by the superior pressure of the entrapped steam. This steam, then expanding, closes or pushes up the double-headed valve, because the pressure is also reduced above the top head; and, as the orifice on the outlet side closes, the steam from the boiler banks up against the inlet side,



thereby increasing the pressure until the small valve becomes unseated; then the full boiler pressure completes the closing of the outlet, and, the valve being shut off completely from the pipe, no steam can pass. The action of the valve is very rapid, but the extension on the top head of the valve and the recess in the top cover act as dashpot, plunger, and cylinder, in which a portion of the enclosed steam or vapor is entrapped, only escaping by reason of the looseness of fit or through a groove cut in either length of cylinder or plunger; consequently the action of shutting off is accomplished without shock or

noise. No spring is used. The valve has been carefully tried under various conditions, and found to work properly." The use of this device would, therefore, seem to wholly remove, or at least greatly lessen, the dangers attending explosions of steam pipes on shipboard, and will be likely to come widely into use unless some more simple means can be made to effect similar results.

The Four-Masted Ship Somali.

PREFACING it with a comment upon the present popularity of "large sailing ships with owners of that class of tonnage," and a partial list of large sailing vessels that have been built on this side of the Atlantic, the *American Shipbuilder* gives a description of the *Somali*, built by Russell & Company, Glasgow, which is said to be the largest four-masted ship ever built, and the largest carrier of any sailing vessel afloat to-day. There is a single vessel, the *France*, which has a larger registered tonnage, but she cannot carry so much cargo as the *Somali*. The following are the respective dimensions of these giant ships: "*France*, length, 361 ft.; beam, 48.8 ft.; depth, 25.9 ft.; registered tonnage, 3,624 tons. *Somali*, length, 329.9 ft.; beam, 47 ft.; depth, 27 ft.; registered tonnage, 3 336 tons. The *Somali* arrived at San Francisco last spring with the largest cargo ever brought to that port from Hongkong by a sailing vessel. It consisted of 2500 tons of coal and 2100 tons (measurement) of general merchandise. She has the largest steering apparatus ever placed on a sailing vessel. There are two steering wheels, at which four men stand in stormy weather. A brass spoke projects outward from the front wheel, and in exceptionally bad weather, when it is necessary to move the wheel quickly, a man is stationed at that, so that at times there are five men at the wheel. Under the wheel-box is a light box—the design of Captain Hannay—to carry a bright light, showing six points on either side, to prevent another vessel from running her jib-boom into the stern at night-time. On the poop is a teak chart-house with a companion way to the cabin; also a telephone, through which the officers of the watch can communicate with the captain in his state-room. The captain's state- and sleeping-rooms right aft, under the poop, are very spacious, finished in teak, mahogany, and bird's-eye maple, and upholstered in maroon plush. In the capacious lazarette are lockers, cemented, for private stores. The rooms are lofty and well lighted with a skylight and a number of port lights. Forward of the captain's quarters is the dining-saloon or mess-room, the officers' and steward's quarters, and a roomy sail-room. A flying bridge from the poop runs the whole length of the vessel. She carries a crew of thirty-eight, all told, including four apprentices. She has in the chocks two lifeboats, a pinnace, a gig, and dingy. The steering compasses are placed 6 or 7 ft. forward of the wheels, so as not to be affected by the ironwork there, and on the top of the petty officers' house is located a standard compass fitted with two ball, soft-iron correctors. She has four capstans and ten bitts on the main deck, and four hatches with combings 36 in. high. Her three forward masts measure 208 ft. from deck to truck, the jigger mast 162 ft. Her spanker boom 47.6 ft., spanker gaff 36 ft., bowsprit 60 ft. from the knightheads out, and the lower yards 90 ft. in length. Her six top-gallant yards are each 70 ft. in length, and no ship afloat has such large ones. The wire rigging is set up by the biggest screws ever made in England and the windlass is the largest one ever made in Glasgow. Her anchors weigh in the neighborhood of 3 tons each. In the engine-house is a centrifugal pump for pumping water for washing decks, condensing water, etc., and machinery for working, by means of a messenger chain, the pumps, hoisting sails and cargo, etc., and for working the windlass and capstans. When the condenser is working, the water can be run by a tube directly to the tanks. The forecastle, or sailors' quarters, located in a house forward, is well lighted and very spacious. The men have a nice bath room under the forecastle deck, where are also located the oil and lamp rooms, and where is kept a patent fog-horn, a Norwegian invention worked by a crank and bellows,

which, when turned, emits a weird, unearthly sound. The boys' quarters aft are fitted up better than the cabins in many vessels. Mr. Morgan, the chief officer, a young man only 27 years old, was in command of the vessel when she was dismasted near Ilo Ilo. Capt. Hannay says that the *Somali* loaded in San Francisco 5700 tons of wheat on a draught of 23 ft. with a freeboard of 6 ft. 8 in."

A Gas-Engine Propelled Barge.

"L'IDÉE" is the name of a new French barge propelled by gas-power, being one of a line of such barges which will ply between Havre, Rouen, and Paris. The vessel is described in *Industries and Iron* (Feb. 1). The engine was designed by Messrs. Delmare-Debouttevillle and Malandin. As far back as 1883 these two gentlemen constructed a tricycle operated by a gas-engine, which was actuated by gas compressed to 22 lbs. per sq. centimeter in two copper cylinders, and it was decided to make a similar experiment, but on a more extensive scale, in the case of barges for the Seine.

The gas for the barge engine is ordinary illuminating gas compressed into steel tubes to 220 lbs. per sq. in. The engine is of the vertical type. The barge is constructed of iron: "Length, 98½ ft., breadth, 18 ft., and draft, 7 ft. 4½ in. The vessel is divided into four watertight compartments. In the front compartment, in the bow of the vessel, are situated the captain's and the crew's compartments. The two middle compartments, extending about four-fifths of the whole length of the vessel, form two large holds, the engine being situated in the compartment at the stern. The vessel has a gross register tonnage of 300, while, having regard to the small space taken up by the crew's quarters and the engine, a cargo of 250 tons may be transported by the vessel. The rudder has a large afterpiece, and is operated by means of chains and a wheel, arrangements being provided for fixing the rudder in any position without the necessity of the wheel being held by the man at the wheel. The steel tubes, forged from a single piece, have an outside diameter of 9.84 in., a thickness of 3.1 in., and a length of 16.4 ft. Each tube weighs 715 lbs., and will contain 22 cubic meters of gas, at a pressure of 350 lbs. The tubes, of which there are altogether eighty, are connected together by flexible joints, similar to those used by the compressed oxygen companies in England and America. The joints have been tested to above the pressure to which they are subjected in actual working, while, to prevent accident, and also to economize space, the battery of tubes has been placed on the captain's bridge, from which on its passage to the engine the gas is expanded to the desired pressure in a special apparatus. Should an escape of gas, therefore, occur, there will be no danger, as the escaping gas will pass off directly into the air."

The engine is a "Simplex" of the vertical two-cylinder type, and drives a McGlasson two-bladed reversible propeller. The connection of the engine with the propeller shaft from the cranks (set at right angles) is made by flexible couplings in such manner that the engine may be disconnected at pleasure from the shaft. The gas, first entering an expanding apparatus, is mixed with air in a special mixing chamber before its induction into the cylinders. Several trials of the efficiency of the engines have been made. With a load of 145 tons, 7½ miles per hour were attained on one occasion over a distance of 45 miles.

An Electric Rudder.

A CURIOUS application of electricity to steering boats is described in *The Electrical Engineer* (Feb. 8). The boat is propelled by twin screws, and the apparatus is so constructed as not only to drive the boat, but, under proper direction, to steer it as well. The illustrations (not available for this review) are necessary to give a complete understanding of the ingenious way in which this invention is worked out, and the device can only be mentioned here as an innovation likely to come into wide use for electrically-propelled launches yachts, etc., when its merits shall have been proved by use. Our contemporary states that one of these motors is at pres-

ent on view at the yachting exhibition of the London Aquarium. It is claimed that, when fully charged, this motor is competent to propel a boat carrying four persons, in still water, at the rate of from 4 to 5 miles per hour continuously for 8 hours. It is anticipated that this motor will be widely used as a substitute for oars in pleasure-boats let for hire at watering-places and pleasure-resorts, since its construction permits it to be adapted to all row-boats without material alterations.

ENGLISH Government docks appear to have been unable to compete with outside builders in engine construction. It is now announced that no more engine building will be done in them. *Industries and Iron* says that the three chief yards—Portsmouth, Chatham, and Devonport—have had repeated trials, and the local officers themselves are obliged to confess that in neither speed nor economy can they compete with outside makers. The explanation they offer is lack of suitable plant, that which they have, although fitted for repairs, being insufficient for construction. From Devonport especially the decision is regretted, as this class of work was found to provide excellent practical instruction for the students at the Engineering College.

THE TECHNICAL INDEX--1895.

Current Leading Articles on Marine Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29150. Lessons of the Elbe Disaster. Robert Gillham (E Mag-April.) 2000 w.

*29179. The Cost of the French Navy. Anon. (E-Feb. 1.) 1600 w.

*29180. Transatlantic Passengers (E-Feb. 1.) 1000 w.

*29213. Sir Edward Harland on British Warships (S L-Feb.) 800 w.

*29214. Launch of a New Cunarder—The "Sylvania" (S L-Feb.) 900 w.

*29230. Steam Pipe Safety Valve. Ill. Invention of J. Batey (Eng L-Feb. 1.) 400 w.

*29232. The Machinery of Our Ships of War. Editorial (Eng L-Feb. 1.) 1600 w.

*29277. The Thomson and Marsden Recorder. Ill. (Eng L-Feb. 1.) 600 w.

*29315. Nine Years of the World's Mercantile Shipbuilding (M E-Feb. 1.) 800 w.

29322. "La Gascogne's" Mishap. Ill. (E R-Feb. 16.) 800 w.

29342. The United States Frigate "Constitution." Ill. (Am S-Feb. 14.) 800 w.

*29411. The New Mayne Electric Rudder Motor. Ill. (E E L-Feb. 8.) 800 w.

*29418. Early Atlantic Steamers. Ill. From the Glasgow Herald (E-Feb. 8.) 1800 w.

*29459. Galway as a Transatlantic Port (Tr -Feb 8) 600 w.

*29463. The Elbe Disaster. Editorial (Eng L-Feb. 8.) 1900 w.

29496. The First Pacific Built Whaleback Steamship. Ill. (Sea-Feb. 21.) 800 w.

29497. Defending Protection for Agricultural Products. David Lubin, with Editorial (Sea-Feb. 21.) 2500 w.

29504. The Piston of the Gascogne Was Fractured. Ill. (S V-Feb. 15.) 1500 w.

29505. Steam Lifeboats. Ill. (S V-Feb. 15.) 1200 w.

*29528. Water Tube Boilers for Marine Purposes Ill. William F. Durand (S J E-Feb.) 5500 w.

29564. The Four-Masted Ship Somali. Ill. (Am S-Feb. 21) 600 w.

*29592. Spontaneous Combustion of Coa Cargoes (F'y-Feb. 15.) 1300 w.

*29644. The Gas Engine Propeller Barge "L'Idee." Ill. (I & I-Feb. 1.) 1200 w.

29746.—$1.25. Contract Trial of the United States Armored Cruiser "Maine." Ill. A. W. Morley (J A N E-Feb.) 7200 w.

29747.—$1.25. Tests of the Boilers of the Steam Yacht "Wild Duck." Ill. Ira N. Hollis (J A N E-Feb.) 4800 w.

29748.—$1 25. Water Tube Boilers. Nabor Soliani (J A N E-Feb.) 12000 w.

29749.—$1.25. Partial Collapse of a Corrugated Furnace Flue. Ill. Charles H. Hayes (J A N E-Feb.) 300 w.

29757. Threatened by a Flower.—A Water Hyacinth That Grows so Rapidly as to Impede Navigation (B J C-March 2.) 1400 w.

*29810. The Yachting Exhibition. Editorial (E-Feb. 22.) 2700 w.

*29849. The Rule of the Road at Sea. P. H. Colomb, with Discussion (J S A-Feb. 22.) 9000 w.

29869. The Beacon Tower of the Plateau of Horaine. Ill. (Sc A S-March 9.) 1100 w.

Serials.

16636. Marine Engine Design. Ill. (M W -Began Sept. 29, 1893—21 parts to date—30 cts. each).

29295. Graphic Analysis of Paddle Wheels with Fixed and with Feathering Floats. Ill. Charles M. Jones (A M-Began Feb. 14—2 parts to date—15 cts. each).

29341. Classification of Lake and Ocean Vessels. Joseph R. Oldham (Am S-Began Feb. 14—Ended Feb. 28—3 parts—15 cts. each).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Sewage Water for Steam-Engine Use.

In the department of Municipal Engineering for this month will be found a review of a process of purification of sewage by aeration, which has been made the subject of experiment at St. Louis. It having been stated therein that the value of this process had been questioned in high quarters, it seems proper to say that at least a partial confirmation of the value of aeration has come from abroad, in a paper contributed to the *Journal of the Sanitary Institute*, and reprinted in *Industries and Iron* (Feb. 8). In this paper an account was given of an attempt to use sewage water for steam-engine purposes. The writer, Alderman Norton, states that mineral matters in sewage water used for steam production are all precipitated, and do not form a hard scale, and that, therefore, incrustation of boilers does not occur in their use. The intolerable nuisance caused by the odor may be obviated. Mr. Norton describes the way in which he was led to experiment with sewage water for steam-engine use as follows:

"I was led to the consideration of this question from the fact that the Palm Mill, of which company I am chairman, occupied a site on the lowest confines of the town. There was a small reservoir on the property, which was fed by a stream which had practically become a sewer for the town; the supply of water was apparently so abundant that we thought we could use it for condensing purposes and let it pass, but a dry summer proved we could not depend upon it without impounding it and using it over again; then the stench became a nuisance, and we were obliged either to make a larger reservoir, costing from £2000 to £3000, or to find a means of making the water innoxious. In order to do this, we built a large cooler, which has since been extended. We did this because I thought it would serve a double purpose of oxidizing the water as well as cooling it, and destroying the nuisance while preserving valuable water. The cooler was built for 2000 h. p., and is 90 ft. long, 24 ft. wide, and 20 ft. high; the water is raised from a hot well by two centrifugal pumps to the top of the cooler, and conveyed in the middle to its whole length by a large trough. This trough has one hundred and forty holes in it, distributing the water into one hundred and forty narrow troughs that are laid the width of the cooler. These are laid perfectly level, the overflow descending in the form of rain onto a lattice bed 2 ft. below, and from that to other lattice beds 2 ft. apart, the whole descending into a small reservoir in the mill yard, and being re-conveyed to the larger reservoir in a cool state. The reservoir, which was originally intended for 150 h. p., is simply used for storing water. The cooler takes about 42 deg. of heat out of the water, varying somewhat in cold and windy weather. From observations we have taken, we find that the cooler requires twice as much water as a reservoir, a considerable quantity being evaporated in steam; but, as we have an abundant supply, the loss is made good by introducing a fresh supply."

Mr. Norton asserts, as conclusions drawn from results of these experiments, that the water falling in the form of rain through the air is changed in character, and that the reservoir, instead of containing a mass of foul, offensive matter, becomes innocuous and comparatively pure. "By descending in innumerable drops, the oxygen of the atmosphere attacks the gas with the following results: the oxygen combines with the sulphur and forms sulphurous or sulphuric acid. It also combines with the freed hydrogen and forms water. The alkaline matter in the water neutralizes the acid, with the result that in the last operation the offensive odor is completely destroyed. That this is the true solution of the operation is proved by the fact that in London the sewage is treated chemically with sulphuric acid and permanganate of

potash, which virtually performs the same operation."

The establishment is said by Mr. Norton to be using about 2000 h. p. at the present time. The cost of the cooler, pumps, and pipes will not exceed £600. The cost of running the plant, inclusive of deterioration, is £26 per annum. The water, 93,300 gals. per hour, has to be pumped to a height of 20 ft. The water, however, is comparatively clean, having in its course been freed of a great part of its undissolved solid matter. The reservoir only accumulated 5 in. of solid matter in the bottom during 6 months' use. Mr. Norton states that Palm Mill now has the advantage of using water that costs nothing, and which is, after the treatment described, of superior quality for raising steam,—giving no boiler incrustation whatever. But his observations do not much favor the project of permanent purification by aeration. He says that, if the water be allowed to stand exposed about a week, it gets foul again, though, if kept in stoppered bottles, it will show no signs of putrefaction; and he thinks the prevention of secondary putrefaction after the treatment would require the water to be filtered through sand or earth.

Effect of Temperature on Indicator Springs.

ACCORDING to a writer in the *Bulletin de la Société Industrielle de Mulhouse*, quoted in *The Practical Engineer*, an indicator spring may be carefully tested, yet the reading will not be the same, "because certain portions of the spiral only come into play with certain loads, and thus the reading of the scale may vary considerably. In transmitting movement to the pencil, the chief object seems hitherto to have been to make the pencil trace a straight line instead of registering the delicate oscillations of the spring." It is not made clear how it is that certain parts of a spiral spring act only when a coiled spring is compressed, unless "certain parts" means *all* parts. This proposition conflicts with principles and formulæ laid down by standard authorities on mechanics.

The author also thinks that the effect of temperature upon the reading ought not to be overlooked. To determine the effect of temperature, he "tested the same spring with the same loads, but at different temperatures, which were measured by a thermometer inside the indicator cylinder. Although the thermometer was separated from the spring by the indicator piston, the temperature, owing to the conductivity of the metal, was practically uniform. By means of a current of hot air it was raised above 212° F., a temperature which he believes is never attained during an engine test, seeing the short time the indicator is in contact with the steam, and considering the large radiating surfaces which carry off the heat. The author proves by calculation that the flexibility of indicator springs increases in a given proportion with each degree of rise in temperature. The chief difficulty in making these experiments is to determine the actual temperature of the spring at the moment of testing. This temperature once ascertained, accuracy can be secured, provided a sufficiently large number of observations are made. The author, however, considers it sufficient in ordinary trials to test the springs cold, the resulting error being not more than 1½ per cent. to 2 per cent. This is compensated by the unavoidable errors in transmitting the variations in pressure on the piston of the engine to the indicator."

Here, again, there is room for the criticism that, if the resulting error is so small that it is compensated by the errors in transmitting the variations in pressure on the piston of the engine to the piston of the indicator, and if, therefore, in practice, the error due to temperature of the spring may be disregarded, the effect of temperature is only of theoretical interest. The method of testing springs which the author used in his experiments is, however, good and practical. For this purpose he "divided the load into a certain number of equal parts, to each of which a line corresponded. The spaces between these lines should be practically the same. Errors due to friction of the spring were obviated by shaking the indicator each time before it traced a line. Two lines were drawn for

each pressure, and the mean of the two taken. As, however, a spring, when released, may not return at once to its former position, but be accidentally deflected for a time, and the error pass unnoticed, the following precaution was adopted: the positions of the pencil as the load increased were verified until the limit of weight had been attained; the spring was then gradually unloaded and tested in the reverse direction." The mean of the readings thus obtained ought, in the author's opinion, to neutralize the effects of any disturbance in the spring while the indicator was at work. He states that, with a skilful operator, the error should be less than 0.1 per cent.

Factor of Stiffness.

MR. F. A. HALSEY, in *American Machinist* (Feb. 14), advocates a departure from the use of factor of safety in machine-designing, and the adoption instead of a "factor of stiffness." He maintains, with some force, that in designing machinery it is not enough in most cases that there should be sufficient strength in the parts to withstand the strains they are destined to receive; they should also have such stiffness that they will not yield injuriously under strains; and he holds that under the usual allowance, called the "factor of safety," insufficient rigidity is a common result. "The fact is—and it is time it were recognized—that all that mathematical analysis can do in these matters is to give the form of the desired formulæ, and any attempt to determine the various constants, factor of safety, etc., from a preconceived idea of the requirements is futile. The only way of arriving at values for such constants is by consulting and averaging successful experience. A fundamental error of conception is involved in introducing a factor of safety as such at all. Bridges and roofs are designed to carry their loads with safety, and that is all that is required of them. The deflection under the load, while a matter of interest, is of very slight practical moment, but in machine construction the deflection is an all-important question. Not many shafts break from lack of strength, but a great many of them run hot because of insufficient stiffness. In point of fact, the factors of safety in many machine-parts are so great as to be almost ludicrous, if considered as such; but, considered as factors of stiffness, their magnitude becomes rational and clear. In some machine-parts the question of stiffness is of relatively small moment, and in such the factor becomes reduced to a figure where it may with some reason be called a factor of safety; but in others, where rigidity as near absolute as possible is desired, the factor introduced is so great as to lose all semblance to a factor of safety. Considered in the usual manner, such differences are simply anomalous, and from no point of view, except the one presented here, can they be explained in a rational manner."

Discussing the strains to which engine-frames are subjected, no general treatment is found possible on account of the great variety of types. The Corliss type is selected as easy to examine and compare, and from data collected from measurements of engines of different build east of the Mississippi river, the following figures are given as the strain per square inch to which the smallest part of the frame (cross-section immediately back of the pillow-clock) is subjected. For engines of the following sizes: 10 in. × 30 in., 28 in. × 36 in., 18 in. × 42 in., 24 in. × 48 in., 28 in. × 48 in., and 30 in. × 60 in., the strains are, per square inch of this cross-section, respectively 217 lbs., 248 lbs., 278 lbs., 360 lbs., 296 lbs., 575 lbs., and 350 lbs. "Other data of a more miscellaneous character show loads of about 300 lbs. on short-stroke engines of about 10 in. diameter of cylinder, while one memorandum of a 32 in. engine which has been running for many years without any indication of weakness gives a strain of 667 lbs."

From these data the rule is formulated that in "engines of moderate speed, and having strokes up to one and one-half times the diameter of the cylinder, the load per square inch of smallest section should be for a 10 in. engine 300 lbs., which figure should be increased for larger

bores up to 500 lbs. for a 30-in. cylinder of same relative stroke. For high speeds or for longer strokes the load per square inch should be reduced in accordance with that final resource in all engineering,—good judgment." It is frankly admitted that these data are not sufficiently comprehensive and definite "to satisfy the over-nice in such matters." The figures are, as factors of safety, "simply absurd, but are intelligible as factors of stiffness." They illustrate well, however, the point made by this writer.

Fly-Wheel Accidents.

THE increase of speed at which engines are run has popularly been supposed to have increased the number of accidents with fly-wheels. Not many years ago the bursting of a fly-wheel was comparatively a rare occurrence. According to a correspondent ("Observer") of *The Boston Journal of Commerce*, there were 13 accidents with fly-wheels in 1892, 12 in 1893, and 6 in 1894 up to September 1. The property loss resulting from these casualties, a list of which is given, is named in only a few out of the thirty-odd accidents listed. The lowest damage named is $10,000, and the highest $40,000. A number of lives were lost, and injuries were sustained by some who were fortunate enough to escape with life. The list is not claimed to be fairly complete except for 1892-3. Probably the number given as occurring in 1894 up to September does not include all the accidents to fly-wheels that occurred during that interval.

These accidents occurred mostly with large fly-wheels, upon which "Observer" remarks that "the difficulty of making large wheels strong enough for the conditions imposed in many kinds of modern service are so great that they seem to be most easily met by not making the wheels so large, and there is considerable testimony in favor of the high-speed small-diameter wheels, such as are now so extensively used."

To sustain this view a fly-wheel accident which occurred a few years ago on a Westinghouse 330-h. p. engine, driving a 3000-light dynamo, is cited. "Lightning wrecked the armature, wedging it into the field and stopping it instantly; the belt failed to go off, and by its grip checked the rim of the engine-wheel, ripping off all the spokes, while the wheel, which weighed about 5000 lbs. and was about 8 ft. in diameter, was running at two hundred and fifty revolutions per minute. The general shock of the disaster upset the valve gear, and caused the engine to run away, injuring it considerably, but the rim of this wheel rattled around on the shaft and floor, broke the remnants of the spokes, and came to a standstill without a crack. It was probably not made of any remarkable metal, nor did it have any favorable conditions to save it. It, however, had the virtue of being small and strong. Many a large wheel has gone to pieces under much less provocation than this wheel resisted."

It is pointed out that these accidents are chiefly taking place with new, rather than with old, engines; that the engines suffering them are chiefly in variable load service (especially in street-railway service); that they are "confined almost exclusively to slow-speed designs and a few moderate-speed engines; that high-speed engines are practically exempt from such accidents; and that it is becoming a matter of monthly record that engines of the type requiring large wheels are dangerous under the service of suddenly variable load. Their weakness seems to lie inherently both in the wheel structure and in the insufficiency of controlling devices common to such engines." The cause last assigned is probably as potent a factor in fly-wheel failures as the insufficient strength of wheels. There seems an imperative necessity for some device that will automatically close the throttle-valve whenever the speed reaches a prescribed maximum, slightly beyond the normal limit, but yet well within the limit of safety. In another review in this department it will be seen that the electrical governing of engines is now and has been for some time a matter of study, and probably in this agent—by which power may be transmitted more rapidly than by any other known—will yet be found the solution of the problem of steam-engine regulation under variable loads.

The Care of Wire Ropes.

WIRE ropes, large or small, now enter into so many mechanical constructions that any addition to knowledge which applies to their care and preservation is important. Mr. John H. Janeway, of Trenton, N. J., has contributed an article on this subject to *The Colliery Engineer*, which is evidently based on a thorough knowledge of wire rope and its uses. He says: "There are many users of wire rope who either shut their eyes to the disastrous effects of friction, or else use materials to modify them which cannot give the desired results with the conditions under which they labor; and they gradually become accustomed to a state of affairs with regard to their wire ropes which ill accords with the general excellency of their other machinery. A wire rope should be considered a machine of many parts, and cared for as such. The necessity of lubricating each wire of a rope (there are from forty-two to one hundred and fourteen in the standard makes) can be easily appreciated when it is understood that they all change their relative positions to each other whenever the rope is bent.

"With a heavy tension on it, the wires grind upon each other, unless oiled. When passing around sheaves or rollers, unless the rope is well coated on the outside, that part will wear very fast. The problem is extremely simple in many cases, particularly in hoists free from water, where nearly any lubricant may be used without fear of its being washed or stripped off. Under other conditions, it is more difficult and complicated."

The lubricant used for a wire rope "must penetrate between all the wires, covering each with a thin film. As a preservative, it must prevent rust, and be free from acids. As a protection, it should turn water and other liquids, and form more or less of a cushion to prevent abrasion." A lubricant specially made to meet all the trying *conditions* to which wire ropes are subjected is now supplied by John A. Roebling Sons Company, but any one who pleases can make it. It consists of tar, summer oil, and mica axle grease, in such proportions as will meet the special conditions under which the ropes are to be used. "The tar and oil must be free from acid. This combination thoroughly penetrates between the wires, prevents rust, and fills the cable, so that it has the appearance of a bar of iron. It sheds water successfully, and does not strip off. Old cables which have been treated with this, when taken apart, show every wire bright and clean, the heart or hemp core being also in prime condition. Linseed oil, on the contrary, frequently hardens around the core, so that it rots and breaks down, destroying the cushion, which the hemp center ought to provide. As soon as the rope has been well filled with this compound, the addition of a very little from time to time keeps it in good condition, so that it is economical besides. The Roeblings state that it costs, in some cases they know of, one-eighth as much per year as the old materials, with far better results. The best manner of applying it is by means of a drip, which pours it on in a fine stream while the rope is in use, care being taken to put it on very slowly."

Electrical Regulation of Steam Engines.

AT the Institution of Civil Engineers, London, a paper on "Regulation of Steam Engines" was recently read by Mr. John Richardson of Lincoln. So far as this paper, an abstract of which is printed in *The Iron and Coal Trade Review* (Feb. 8), relates to mechanical regulation, it appears to advance no ideas beyond those very thoroughly treated by preceding writers, going over about the same ground that is covered—though less thoroughly—by Mr. H. J. Conant in his paper, "The Ideal Steam-Engine Governor," printed in this magazine for October, 1894. What Mr. Richardson says with reference to electrical governing is of greater present interest, as there can be little doubt that electricity, ere long, will come to the front in engine-governing as it has done in so many other important applications.

"The conditions which obtain for an engine driving a dynamo are not quite the same as those for maintaining a constant speed of other machinery; as, if the electric current produced by the engine were

used to control its speed, it becomes possible either to run the engine at a practically uniform speed in connection with a perfectly-compounded dynamo, or to run it at a varying speed, maintaining either a constant difference of potential with a varying current or a constant current. Further, it was shown that by utilizing the changes in the current to control the engine, it is possible when the load is suddenly decreased to effect what is impossible with a speed governor,—namely, to shut off for a time the whole of the steam supply before the engine has had an opportunity of increasing its speed. A number of appliances which have been devised during the last fifteen years and tested for electrical regulation were described, some as examples of what should be avoided and others as successful. In most of these latter a solenoid, the core of which is held in a varying position within it by the current, is connected in different ways to the valves. Two forms of electric motors for altering the position of valves were also shown, and other forms of relays. The advantage of the direct connection of the solenoid over any form of relay appears to be very great."

The paper concludes with a description of a method of "electric control of a valve-gear suitable for engines of large size, the power required to govern the lever being practically nil, a small solenoid and a slight current being found sufficient to effect the entire control of engines up to 1000 h. p. An automatic method of stopping or slowing the engine, should there be an accidental breaking of the governor circuit, was also discussed."

Sawing Stone by Wind-Power.

AN account is given in *Stone* for February of what is believed to be the only mill in North America that uses wind-power for sawing stone. This mill—the property of John Kline, Jr.—is located at Halifax, Nova Scotia, and the owner, at the request of *Stone*, has supplied the data for the description. His principal reason for adopting wind-power in preference to any other motive power was "that fuel is quite expensive in Nova Scotia, notwithstanding it is a coal-producing country." Another reason was that "with this power he could let his mill run windy nights with less attention, the wind in that region being of a more uniformly steady character than in the lower countries of the temperate zone. Thus a material saving is effected over steam-power, and a larger production is assured. The wheel adopted is 16 ft. in diameter. It runs a gang of three blades in excellent shape under a light breeze. Mr. Kline figures out a positive saving over steam of $3.00 a day, not counting his saving in labor; and the mill is yet an experimental one in the application of the most modern machinery for sawing stone. The mill is set to saw 1 1½ in. per hour in granite, and it is said to be doing the work splendidly. It is guaranteed to furnish sufficient power under an ordinary wind—say one of 5 to 8 miles an hour in velocity,—to cut 3 in. an hour in the hardest granite, using crushed steel for feed to the saws. The machine works true, and is under regulation to any speed desired in any wind less than a tempest." It is editorially added that Mr. Kline intends to equip his wind-power mill with the latest improved machinery, and to test the full capacity of the wind-mill in working stone.

Simplon Tunnel Ventilating Fans.

AN illustrated description of these great fans is given in *The Engineer* (Feb. 1), abstracted from the specifications of the Simplon Tunnel Company. "Not only will air be required for the workmen and for clearing away the gases generated by the locomotives, or in blasting, but the contractors rely on the constant circulation of large volumes of fresh air to lower the temperature in the centre of the tunnel to a degree at which the work can be carried on without inconvenience. The fact that the rock-drills are driven by water instead of by compressed air renders an independent air-supply even more imperative." There will be two fans at the end of the tunnel, either of which may be used to draw air out of the tunnel or force air in. Of course, while one is forcing air in, the other may draw air out, thus enabling the

blowers to act materially in effecting a rapid change of air in the tunnel. When they work together to force air into the tunnel, they can deliver double the quantity at the same pressure or the same quantity at double the pressure. These fan-blowers are each 18 ft. in diameter, and each capable of delivering into or drawing out of the tunnel 1750 cubic ft. of air per second (6,300,000 ft. per hour) under a pressure of 9.75 in. of water. When acting together, they can deliver the same quantity at 19.5 in. of water pressure, or they can deliver 3500 cubic ft. per second at the first-named pressure,—that is, 12,600,000 cubic ft. per hour. The blowers of each pair will be arranged one behind the other, and provided with masonry flues and valves whereby to effect the described changes in action. The plant is not yet erected at the ends of the tunnel, but one of the fans has, it is said, been tested with results that assure their capacity to meet the requirements. The fans are made of wrought-iron plates with channel-iron arms and cast-iron naves. Very few if any fan blowers of larger size than these have ever been installed, and their construction and arrangement are instructive models for large ventilating operations.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

The Machine Shop.

*29776. Mast Traveller for Erecting Heavy Work. Ill. James F. Hobart (A E R J-March.) 1000 w.

*29818. Machine Tool-Making at the Atlas Works, Glasgow. Ill. (Eng L-Feb. 22.) 1000 w.

29865. Modern Machine Shop Practice. C. R. Tompkins (A S-March 2.) 1300 w.

29870. Gumming the Patternmakers' Saw. John M. Richardson (A M-March 7.) 1800 w.

Steam Engineering.

*29210. Effect of Temperature on Indicator Springs. Anon. (P Eng-Feb. 1.) 600 w.

29246. Steam Engine Economy. P. Batty (C Eng-Feb.) 1700 w.

29247. Water in the Boilers. W. Sutton (C Eng-Feb.) 1800 w.

29296. Rules for Engine Proportions. F. A. Halsey (A M-Feb. 14.) 1000 w.

29362. Fly-Wheel Accidents.—A List of Large Engine Failures. Observer (B J C-Feb. 16.) 1500 w.

29403. The Willans Law. W. E. Burgess (E E-Feb.) 1100 w.

*29421. Governing Steam Engines by Throttling and by Variable Expansion. H. Riall Sankey (I & I-Feb. 8.) 8500 w.

*29464. The Purification of Sewage Water for its Use for Steam and Condensing Purposes. Alderman Noton (I & I-Feb. 8.) 1600 w.

*29483. The Mechanical and Electrical Regulation of Steam Engines. (Abstract.) John Richardson (I C T-Feb. 8.) 1100 w.

29503. The Schmidt Motor. Ill. (S V-Feb. 15.) 2400 w.

29535. A Comparison of Boilers.—Merits of Various Types. Thomas Hawley (B J C-Feb. 23.) 3000 w.

*29624. The Straining of Boilers. Editorial (P Eng-Feb. 15.) 1000 w.

*29642. Priming and Governing Engines. Editorial (Eng L-Feb. 15.) 1900 w.

29678. Safety Valves and Other Safety Devices. D. Rivers (S E-Feb.) 2300 w.

29680. To Obtain Smokeless Combustion. I. Bowe (S E-Feb.) 3600 w.

29692. Testing Flue Gases. Ill. W. H. Booth (A M-Feb. 28.) 900 w.

29694. The Flow of Steam in Pipes. William Cox (A M-Feb. 28.) 1200 w.

*29819. High Duty Pumping Engines. Editorial (Eng L-Feb. 22.) 1900 w.

*29858. Margins of Safety in American Boiler Practice. Editorial (P Eng-Feb. 22.) 900 w.

*29360. The Economical Development of Mill Engines. J. Mills (P Eng-Feb. 22.) 2800 w.

29870. Free Expansion. George I. Rockwood (A M-March 7.) 1700 w.

29885. A Petroleum Heating Apparatus. Leemann-Baumgartner System. Ill. (Ir Age-March 7.) 2200 w.

29890. Entropy. R. C. Carpenter (Pr-March.) 1800 w.

29897. Proper Methods of Steam Piping. Ill. Frederick Fosdick (M A-March.) 1800 w.

Miscellany.

*29173. Notes on Power and Power Attachments. Anon. (Mill-Jan.) 2000 w.

*29190. The Care of Wire Ropes. John H. Janeway, Jr. (C E-Feb.) 700 w.

*29204. Manufacture of Brass and Bronze Goods. James Powell (The Ohio Valley Industrial Review of Jan.) 1200 w.

*29233. Ventilating Fans for the Simplon Tunnel. Ill. (Eng L-Feb. 1.) 500 w.

*29255. Sawing Stone by Wind Power. Ill. (S-Feb.) 700 w.

We supply copies of these articles. See introductory.

29294. The Proposed New Standard Screw Thread—Views of Firms, Mechanics and Others (A M-Feb. 14.) 3000 w.

29297. Drop Hammer Foundations. Carl Norland (A M-Feb. 14.) 2800 w.

29388. The History of the Bate Refrigerator Case and the Probable Effects of the Decision. W. B. Vansize (E R N Y-Feb. 20) 1100 w.

*29435. Experiments on the Strength of Copper. A. Martens (P Eng-Feb. 8.) 1200 w.

*29436. Welded Steel Steam Pipes. Warren E. Hill (P Eng-Feb. 8.) 1200 w.

29506. The Handling of Coal and Ashes at the Third District Station of the Edison Electric Illuminating Company, Brooklyn. Ill. (W E-Feb. 23.) 700 w.

*29509. Blowing Fans. Ill. Souffleur (M W-Feb. 15.) 700 w.

*29529. The Second Law of Thermodynamics. R. H. Thurston (S J E-Feb.) 4600 w.

†29688. Wellner's Sail Wheel Flying Machine. Ill. Helene Bonfort (P S M-March.) 2500 w.

29690. Weight and Mass. Charles T. Porter (A M-Feb. 28.) 1400 w.

29693. About Reheating Compressed Air. Frank Richards (A M-Feb. 28.) 2000 w.

*29821. New Elswick Eight-Inch Quick-Firing Gun. Ill. (Eng L-Feb. 22.) 2000 w.

*29877. The Transmission of Power. C. R. Tompkins (Am M-March.) 1000 w.

29900. The Pitch and Strength of Gear Teeth. Samuel Webber (M A-March.) 1200 w.

29901. Finding Squeaks and Knocks in Machinery. John H. Cooper (M A-March.) 1500 w.

29923.—$1.50. Platen Presses for Letter-Press Printing, Embossing, Cutting and Scoring. Ill. John Thomson (T C E-Dec.) 12800 w.

29937. Boiler Steel Requirements. From the Boiler Maker (I T R-March 7.) 1200 w.

29938. Lubricating and Bearing Cooling Devices in the Niagara Falls Power Plant. Ill. Frank C. Perkins (W E-March 9.) 500 w.

29941. Economy of Power House Operation. J. B. Craven (M S P-March 2.) 1800 w.

Serials

13033. Practical Hints to Boiler Makers and Templaters. Ill. (M W-Began May 12, 1893—16 parts to date—30 cts. each).

13534. The Gas Engine (M W-Began June 2, 1893—14 parts to date—30 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7, 1893—Ended March 7, 1895—20 parts—15 cts. each).

21141. High Speed Steam Engines. John Radinger (E M-Began April, 1894—11 parts to date—30 cts. each).

24338. The Gas Engine. Ill. Anon. (P A-Began Aug. 15—9 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (El-Began Aug. 31—14 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Scheffler, Jr. (M A-Began Oct.—6 parts to date—15 cts. each).

25611. Calculation of a Compressed Air Transmission When the Subsidiary Losses of Energy are Taken Into Account. From Professor Unwin's "Development and Transmission of Power" (E M-Began Oct.—4 parts to date—30 cts. each).

27574. The Stresses on Hemp Ropes and Leather Belts Used for Driving. M. Fauquier (P Eng-Began Nov. 30—Ended Feb. 8—4 parts—30 cts. each).

27594. Erection of a Corliss Engine. A. S. Mann (Pr-Began Dec.—4 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (M W-Began Dec. 7—4 parts to date—30 cts. each).

28021. Attachments and Conveniences for Milling Machines. Ill. Warren E. Willis (A M-Began Dec. 27—3 parts to date—15 cts. each).

28400. The Building of a Locomotive Boiler. W. D. Wansbrough (M W-Began Jan. 4—4 parts to date—30 cts. each).

28401. Boiler Trials. W. H. Wakeman (M W-Began Jan. 4—Ended Feb. 1—3 parts—30 cts. each).

28745. The Trials of Oil Engines at Cambridge. Ill. (P Eng-Began Jan. 18—5 parts to date—30 cts. each).

28926. Recollections of the Use of the Steam Indicator. F. F. Hemenway (M A-Began Feb.—2 parts to date—15 cts. each).

28967. On Results of Evaporative Tests in Land Boilers. George Carruthers Thomson (E-Began Jan. 25—Ended Feb. 15—3 parts—30 cts. each).

29417. The 48th Annual Meeting of the Institution of Mechanical Engineers (E-Began Feb. 8—Ended Feb. 15—2 parts—30 cts. each).

29484. The Determination of the Dryness of Steam. W. Cawthorne Unwin (I C T-Began Feb. 8—Ended Feb. 22—2 parts—30 cts. each).

29488. Some Reminiscences of Steam Locomotion on Common Roads. Ill. Frederick Bramwell (I Eng-Began Jan. 19—2 parts to date—45 cts. each).

29620. Underground Pumping Engines. H. Debauche (C G-Began Feb. 15—Ended Feb. 22—2 parts—30 cts. each).

29630. The New Nordenfelt Guns. Ill. (E-Began Feb. 15—2 parts to date—30 cts. each).

29777. The Deterioration of Locomotive and Marine Boilers Due to Expansion and the Means of Lessening the Same. Herr Lentz (A E R J-Began March—1 part to date—30 cts).

29886. Defects in Steam Boilers—From Report by the Austrian Association of Engineers and Architects (Ir Age-Began March 7—1 part to date—15 cts).

We supply copies of these articles. See introductory.

MINING & METALLURGY

A Great Drainage Tunnel.

AT Park City, Utah, is one of the greatest drainage tunnels connected with any mine. It is not quite so long as the Sutro tunnel and a few of the German tunnels, but is remarkable on account of the difficulties encountered, and also because the expense was met by but two mines, the Ontario and the Daly. The Salt Lake *Tribune* contains an interesting account of its history. The Ontario, after spending much money in pumping, about a dozen years ago ran its first drainage tunnel, about a mile long, tapping the 600-ft. level of shaft No. 3. As the mine became deeper, a very heavy Cornish pumping engine, with double 20-in. pumps, was put in to raise the water from the 1200-ft. level to this tunnel. Great steam pumps were added, and with difficulty and enormous expense the mine was unwatered down to the 1500-ft. level. But the costs were so great as to induce the managers to start another drainage tunnel in July, 1888, at a point 15,400 feet from where it was to tap No. 2 shaft, 1500 feet below the surface. For the first mile it is in porphyry, and thence to the 14,600-ft. mark in limestone with bunches of porphyry, the rest being in granite.

The difficulties from loose ground, cave-ins, and water were great. In November, 1889, a cave-in caused a delay of three months. Two side drifts, each 150 ft. long, were put in to drain the ground beyond, while repairing the caved portion. A year later a fire swept away the plant at the tunnel mouth, causing a loss of 60 days' time and $30,000. Just another year later a blast at the face let loose a flood, which drove every loose thing out of the tunnel, necessitating the raising of the tram track 18 in. and causing a delay of 71 days. In May, 1892, another flow was struck, causing a delay of 65 days,—a loss of 266 days by these four accidents. Other and numerous delays were caused by loose ground, which would run in as fast as it could be removed. In such cases piling had to be driven ahead, and in one instance it took 6 weeks to put in a 5-ft. set of timbers, when, after 2 weeks' preparation for the next set, the shoe on the other was found to be broken and the set had to be renewed—altogether 10 weeks of hard work required to gain 10 ft. At another place far back of the heading a small stream opened into a large crevice, causing a flow which shot out 100 ft. from the tunnel mouth, cutting through a bulkhead of 3-in. planks in a few hours.

A plant of compressors and blowers at the mouth supplied power and ventilation, the latter being always good, though the tunnel is one of the longest ever driven with only one heading and no intermediate shafts. The danger was not at the heading, but from swelling ground and crushed timbers behind. Constant watchfulness was demanded, and the pressure eased, crushed timbers being replaced by new 12 × 12 in. ones and steel bars, which did not always last long. Three 8-hour shifts worked continuously, except when accidents prevented.

The flow of water is now 10,000 to 15,000 gallons per minute, part of which is being used for power and light in the mills.

The total cost of the tunnel was about $425,000. It was completed October 10, 1894, the alignment being found to be very perfect. Inside of timbers it is 9 ft. high, 4½ ft. wide at top, and 5½ ft. at the bottom, with a water flume 5½ ft. wide and 21 in. deep. Total cutting is about 9 × 11 ft. The grade is ½ in. per rod.

Diamonds.

VERY many diamonds of small size have been found from time to time in the gold placers of California and at various localities in the southern Appalachians. The recent finding of two diamonds (of 2 and 1½ carats) in El Dorado county, California, has led the *Mining and Scientific Press* to publish an article on the occur-

rence and proper mode of prospecting for diamonds. "It may be," says the *Press*, "that some prospector will find a diamond mine,"—which is certainly very possible, in view of the frequent isolated discoveries in the United States.

Mr. Melville Atwood has classified the placers into three types,—surface washings, recent river beds, and ancient river beds. Such placers, yielding both gold and diamonds, occur in Brazil and California.

The outfit recommended by Mr. Atwood for diamond prospecting is elaborate, consisting of a light pick, a shovel, and two screws, one having ¾-in. apertures and 18-in. diameter, the other having eight holes to the linear inch, a large sack (a "miner's wallet"), a tub for washing the gravel in, a piece of rubber cloth for sorting the gravel, a watchmaker's lens, and a scale of hardness consisting of fragments of diamonds, sapphires, and quartz set in the end of a pencil in lapidaries' cement. The sample is put into the coarse riddle, and that fastened over the finer one. Both are immersed in a tub of water, the coarse gravel being caught on the top riddle, and mud and sand falling through the lower. Then the coarse is thrown away, and the top riddle unfastened; the lower is then jigged to get the heavier particles to the bottom and at one side, and this material is turned over quickly on the rubber to bring the heavy particles to the top. The stuff is then tested with the diamond scale pencil, and the particles examined with the lens. If no scratch is found upon one, it must be a diamond, no matter what the color or shape.

Mr. E. I. Dunn thinks that diamondiferous volcanic pipes, like those of South Africa, may yet be found in California.

A late discovery at Mt. Edgecombe, Alaska, shows that diamonds may occur in pumice and scoria.

Like the tedious and laborious prospecting operations described above, the actual treatment of diamondiferous earth on the large scale in South Africa is also very slow, but very sure. It is said that a half-carat diamond may be mixed with 200 lbs. of earth with the perfect assurance that it will not escape the various machines or the sorters.

It is established that the supposed diamonds found in meteorites near Cañon Diablo are actually such. Microscopic artificial diamonds have been made from other forms of carbon by means of the electric battery.

The total value of rough gems of all sorts produced in the United States in 1894 has been estimated at $237,000, of which diamonds formed too insignificant a part to be counted.

Acid or Basic Open-Hearth Plates.

FOR some time there has been sharp competition between the manufacturers of the two types of open-hearth steel, and it has been most intense in the case where the requirements are most rigid,—that is, in ship plates and boiler plates. As in the case of the old controversy between the different varieties of Bessemer steel, the basic process seems to have been gaining in favor, not simply because it can be produced at lower cost, but on its merits. The *Iron Trade Review*, which has devoted considerable attention to the question, lately said: "Both sides have had their victories, and the campaign is being pushed with vigor among ship-building companies." In a still more recent issue it remarks that "in one case specifications have been made that evidently leaned toward basic material, since 'open-hearth steel,' without qualification, was called for, and the question thus became merely one of price, with the result a foregone conclusion."

A writer in the *Maritime Review* (described as the head of one of the largest ship-building firms on the lakes), criticising an article in that journal, says: "The leading points sought to be made are (1) that the basic process is a new and untried one, recently resorted to for the purpose of obtaining at a reduced cost an open-hearth steel suitable for ship plates; (2) that basic open-hearth steel is inferior to the acid open-hearth, for the alleged reason that cheaper raw material is used in its production." The writer, admitting that it is true that the basic process is a compara-

tively new one in this country, argues that nevertheless it has been in successful use for a number of years at some mills in the production of boiler plates, etc., in which it had made for itself a recognized place long before its use for hull construction was contemplated, which has been only within the last year or so. He calls attention to the fact that in Europe, however, it has been in use for a long time, and for purposes requiring the highest qualities; that, after extensive investigations by the admiralties of the leading countries, it was adopted for the construction of war vessels; and that the United States government is using it freely in the construction of its new navy.

As to the metallurgical questions involved, the same writer says: "In the acid open-hearth process materials are selected which are sufficiently free from phosphorus and sulphur to produce the desired results in the finished material." He then claims that the acid process will not eliminate any of the phosphorus and sulphur impurities in the melting stock, and that, as the weight of the steel is reduced by oxidation of silicon, iron, etc., the percentage of the phosphorus and sulphur in the finished metal actually increases slightly. "The procedure of the basic manufacturer is precisely the same . . . [but], the basic process being essentially a refining one, these impurities are to a large extent removed." Finally he admits that there have been instances of failure of basic steel, but says that no one who knows anything about steel-making would pretend that the same thing has not happened with acid steel. The general conclusion seems to be that bad steel can be made by either process, but that, with careful selection of raw material and rigid specifications and tests, either will succeed.

Dredging for Tailings at Dayton.

IT is well known that an enormous value exists in the tailings from the Comstock lode, Nevada, and is contained in the sands of the Carson river below the mills. The total production of the lode has been over $400,000,000 worth of ore, but of the assay value not over 75 per cent. has been recovered. At first very crude processes were in vogue, losing at least one-third of the assay contents; later the wet-crushing, pan amalgamation mills guaranteed an extraction of 65 per cent., and finally of 72 per cent. Of the tailings in the river it is not known how much is recoverable, but the valuation is known to be so large that for very many years attempts were made by many persons and in various ways to recover some of the lost millions. The most persistent attempt has been by dredging, but hitherto with indifferent or no success.

The *Mining and Scientific Press* now announces that dredging is no longer an experiment, but from a financial point of view a decided success. The *Press* illustrates the fine plant of the Carson River Placer Mining and Dredging Co., a company which, after eight years of experiment costing $120,000, built last year a most elaborate plant for working on a large scale, having proved that great capacity was an absolute requisite. Most parts of the machinery are original in design, and the labor-saving devices are many and ingenious. The plant consists, first, of a powerful clam-shell dredger, capable of handling from 1500 to 4000 tons of the river material per day, the amount varying with the condition of the river and proportion of rock, gravel and sand to be handled. Its engine is 150 h. p. Attached to the dredger is a barge carrying the screening machinery, agitators, quicksilver traps, sluices and riffles, etc. The power on the barge is furnished by two Pelton wheels of 80 and 30 h. p., driven by water conducted from a point several miles up stream. The shore plant is a three-deck mill, driven by outer impact wheels, containing a centrifugal pump, twenty-two concentrators, and a distributor. The fourth part of the plant is a mill for working the sulphuret concentrates. [The tailings contain free metals (gold, silver, and quicksilver) and gold- and silver-bearing sulphurets.]

The dredger delivers the material into a hopper, where cobbles and gravel are removed by grizzlies, the finer material passing into revolving screens in series down to 30-mesh. The pulp passing this mesh

averages about 25 per cent. of the whole, and is sent by a centrifugal pump to the concentrating mill to another pump, which raises it to the distributor on the upper deck, whence it passes to the concentrators below. The system of sizing and concentration is very elaborate, since in the concentration and reduction mills the different classes of material require different treatment, the process being based on the continual elimination of barren sand and gravel under conditions favorable to recovering amalgam, free quicksilver, free gold, and sulphurets. The recovery really begins at the hopper, and continues by various devices, including riffles, traps, sumps, amalgamating plates, settling pans, and special treatment of sulphurets.

The Wall Rocks of California Gold Mines.

IN the *Engineering and Mining Journal* Mr. W. H. Storms discusses the question of the influence of particular kinds of country rock or combinations of rocks on the richness and continuity of gold veins, and cites a very long list of examples in support of his views. After referring to the prejudice miners have for certain formations, he asks: "Are such prejudices well founded? Is it a fact that any particular kind of wall rock or combination of wall rocks may be considered an index of the value of a vein? Is a vein in a particular formation likely to prove more remunerative than in some other kind? Are ore shoots influenced in any manner by the wall rocks inclosing them?" The author admits that he may personally share with miners generally their prejudice for or against this formation or that, but thinks, "on the whole, that wall rocks are not a safe indication of either the richness or poverty of the vein or of its continuity." He does think, however, that "a careful examination of the wall rocks of a vein, as to whether they have undergone alteration from the normal rock or not, and to what extent this alteration has progressed, as well as an inquiry as to the causes which have brought about the change, will furnish a far safer basis for judgment than the mere fact that the walls are of this or that kind of rock." In this doctrine Mr. Storms will have the support of the most advanced opinion; that is, when applied to large areas containing scattered mines of any mineral. Yet probabilities are better than nothing, and they certainly can often be drawn for any given district that has been developed in part. It seems perfectly reasonable to look for similar results in a limited district where the same causes would be expected to have operated, while on the other hand (as is well known from experience) at distances entirely different sets of conditions may exist. In the case of gold mines the variations are very numerous.

Treatment of Gold Slimes.

WHILE great progress has been made in the recovery of gold from battery tailings, scarcely any practical attempt has been made, says the London *Mining Journal*, to extract the metal from the slimes. This timely observation is backed up by the *Journal's* statement that nearly 600,000 ounces of gold were produced from tailings by the Transvaal mines alone last year; but it must be remembered that the peculiar treatment followed there does not aim at very close preliminary recovery, since in the Transvaal the working of tailings has been brought to a high stage of efficiency and economy, so that the first recovery is not so important as in other regions where the methods are different,—as, for example, in California and Colorado. Slimes are always made in wet-crushing, but the *Journal* estimates that in the Transvaal probably $1,500,000 is annually lost by the inability to treat them. "One radical proposal is simply to prevent the formation of slimes by increasing the fineness of crushing,"—which is rather a paradox. The *Journal* suggests dry crushing, by centrifugal and roller mills or by the substitution of pneumatic power for hydraulic in the ordinary stamp battery. This is just what has been done in many silver mills in Nevada, Idaho, and Montana, where roasting was necessary prior to amalgamation. But the *Journal* believes that the interference with existing plants that would result from a change to dry crushing is not likely to take place while

the prospect of dealing separately with the slimes remains a hopeful one. It says that the claim is made that, so far as rich slimes are concerned,—that is, containing about 7 dwts. per ton,—successful treatment has already been achieved. The method is described as "disintegration and subsequent pressure." If the slimes are rich enough, they may be settled, bricked, and sent to a lead-smelter, if there is one near by; the question is as to low-grade slimes.

British and American Iron and Steel Trades.

COMPETITION in neutral markets for iron and steel between England and its continental rivals, Belgium, France, and Germany, has for some time been a theme of anxious study by English iron-makers. Now a new cause for alarm has been discovered in American competition. The *Coal and Iron Trades Review* (London), quoting a paper by Mr. Jeremiah Head, a high English authority who has visited the iron-making districts of the United States for the purpose of investigating costs of making and marketing iron and steel, says that the paper points in unmistakable terms to the coming supremacy of the United States in the manufacture of pig iron. "It is true that we have not yet been flooded with this cheap American (Alabama) iron in European markets, but it is not at all improbable that this event will happen by and by. The drawback to the success of the Alabama iron-makers at the present time is the comparative high cost of transport. Whether land and ocean transport will in the future be reduced sufficiently to enable a change to be made from this point of view is of course an unsolved problem, but the margin of 5*s.* now in favor of Alabama iron must be increased considerably before we need fear the advent of that product on British soil to any extent worth speaking of." The *Review* then goes on to say that certain other branches of the English iron and steel industries have been attacked successfully under conditions that may well cause a good deal of disquietude. Pittsburgh steel billets have been brought to about 6*s.* 6*d.* below Glasgow or Sheffield rates, and American wire manufacturers are leading in Central and South America and doing considerable business in Canada. The *Review* considers it "a curious economic problem" that this should have happened in a country where wages are understood to be 25 to 30 per cent. more than in England.

The Miner's Place in the World.

THE *Mining Industry*, of Denver, makes a strong plea for recognition of the miner. Among other things, it points out that the two productive industries which have made civilization possible are agriculture and mining, the former furnishing food and clothing, the latter the materials with which mechanical progress is made and the money which is the tool and servant of commerce and without which mankind would yet be swapping and as far behind the age as the fur-trading Indian is behind the banker and merchant. "The first occupation is a necessity of existence; without the second, civilization could not exist. Man emerged from a state of savageness only when he began to utilize metals, and his progress ever since has been measured by his advance in their use. We find the proof of this in the classification of the periods,—the stone, copper, bronze, iron, and, lastly, the gold and silver ages. The gradations of progress must have been first a hunter, secondly an agriculturist, and thirdly a miner. . . . Mining and metallurgy are the oldest of sciences. . . . Without the miner and metallurgist there could have been no iron and steel for tools, no coal for making them, nothing to set in motion the machinery, the arts, and the manufactures." The *Industry* claims that no racial exodus was ever begun for agricultural or climatic reasons, and cites the cases of antiquity,—of the Phœnicians going to Cornwall for tin then a precious metal; of Carthaginians and Romans ransacking Spain for gold and silver; of the Spaniards settling the new world in their search for gold. In later times: "California to-day would still be a drowsy Mexican province," had not Marshall one day found gold there. "Australasia would still have been the

Botany bay of banished convicts, if gold discoveries had not called to it a civilization unexcelled on earth." But it is needless to quote further; the imagination, once started, will fill in, imperfectly at least, the outlines of the picture.

Ontario's Effort to Make Pig Iron.

HITHERTO this important province has enjoyed the unenviable reputation of being without a single iron blast furnace, notwithstanding its large population, its local markets, and its rich resources in coal and iron ore. This is soon to be changed, however. *Iron Age* publishes a description of a large furnace plant, being built at Hamilton. It will have a 150-ton stack, 75 ft. high and 16 ft. wide at the boshes, provided with all modern appliances. The site, granted by the city of Hamilton, is said to be particularly advantageous as to cheap handling of material and product, being on a short branch of the Grand Trunk railroad and having ample dock facilities. It is stated that it will have an advantage of $5 per long ton over Nova Scotia competition. In freight there will be little advantage over American iron, but the duty and bounty combined ($6.72 per long ton) are almost equal to the cost of making iron in some parts of the United States.

Mica in Georgia.

A WRITER in *The Tradesman* (Feb. 15) states that mica is found in Georgia, associated with the veins of granite "which are in places interstratified with schists" containing gold bearing ores. The leads or belts have a northwesterly and southwesterly trend but only yield in pay districts at varying distances from each other. At present mining for mica is at a standstill in this region. The counties of Cherokee and White contain all the paying districts yet discovered in the state. The workings are said to be very shallow and neither the extent nor the permanency of the deposit are yet determined. The industry is retarded by lack of convenient railway transportation. A railroad into Lumpkin county is proposed, and, if constructed, will penetrate a mineral bearing district, containing not only mica, but gold, asbestos, soapstone, and corundum. These minerals are said to exist in Lumpkin county in quantities that may render mining profitable as soon as the requisite facilities for transportation are afforded, and provided also that the demand equals the supply. With carborundum as a commercial rival to corundum, and chemically prepared scrap-mica as a rival for mica, the prospect of such a demand may be doubtful.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Metallurgy.

*29152. Economic Possibilities of the Milling Machine. Horace L. Arnold (E Mag-April) 3000 w.

*29231. Tin-Plate in Wales and the United States. Editorial (Eng L-Feb. 1.) 1600 w.

29251. Melting and Refining Gold Bullion. Van F. Furman (Min R-Feb. 8.) 2500 w.

29274. Producer Gas as Applied to Foundry Purposes. George T. Prince (Ir Age-Feb. 14.) 3800 w.

29298. The Refining of Go'd Sulphides. Werner Langguth—Read at the Virginia Beach Meeting of the Amer. Inst. of Min. Eng. (M S P-Feb. 9) 1600 w.

29344. Mescaba Ores in the Furnace (A M & I W-Feb. 15.) 1000 w.

§*29350. New Processes of Gold and Silver Extraction. Anon. (A M S-Dec. 29.) 900 w.

29371. American Iron Products in Canada. (Extract) George E. Drummond (I T R-Feb. 14.) 1300 w.

29376. Northern versus Southern Iron—Some Points of Interest to Southern Iron Makers. C. A. Meissner (T-Feb. 15.) 2000 w.

*29431. The Principles of Lead and Copper Smelting (C T J-Feb. 9.) 600 w.

*29469. The Treatment of Gold Slimes. Editorial (M J-Feb. 9.) 700 w.

*29477. The Hematite Ore Trade and Its Revival. Walter J. May (C G-Feb. 8) 1500 w.

29500. Mesuré and Nouel's Optical Pyrometer. Ill. F. E. Thompson (Ir Age-Feb. 21.) 3500 w.

29501. Ontario's Effort to Make Pig Iron.—The Hamilton Furnace and Its Prospects. Anon. (Ir Age-Feb. 21.) 1500 w.

29547. British vs. American Iron and Steel. Editorial (E M J-Feb. 23) 1300 w.

We supply copies of these articles. See introductory.

29551. Lead Smelting in Scotland. A. H. Sexton (E M J-Feb. 23.) 1400 w.

29552. Proposed Eight Hour Day at English Furnaces. Anon. (E M J-Feb. 23.) 700 w.

29583. Acid or Basic Open-Hearth Plates. From the Marine Review (I T R-Feb. 21.) 1000 w.

29597. The Magnetic Properties of Nickel Steel. Edward P. Buffet (A M & I W-Feb. 22.) 1500 w.

*29614. The Solubility of Basic Slag. C. H. Ridsdale (C T J-Feb. 16.) 1000 w.

29683. The Uehling and Steinbart Pneumatic Pyrometer. Ill. (Ir Age-Feb. 28.) 1000 w.

29713. Abandoned Furnaces of the East. From the Philadelphia Record (I T R-Feb. 28.) 1000 w.

29714. Bench Molding. J. W. Dearsley (I T R-Feb. 28.) 1000 w.

29734. Barrel Chlorination of Gold. William M. Brewer (T-March 1.) 3300 w.

*29750. The Metallurgical Industries of Russia (B T J-Feb.) 900 w.

†29791. Separation of Nickel and Iron. E. D. Campbell and W. H. Andrews (A C J-March.) 700 w.

*29814. The Desulphurization of Liquid Pig Iron. Review of Article by A. de Vathaire (C G-Feb. 22.) 1100 w.

*29823. Plant for the Extraction of Gold by the Cyanide Process. (Abstract.) Charles Butters and Edgar Smart (Eng L-Feb. 22.) 800 w.

*29852. The Painting of Iron. A. Ashmun Kelly (I C B-Feb. 22.) 900 w.

29884. The Lake Superior Ore Situation (Ir Age-March 7.) 2000 w.

†29896. Science in the Foundry. Alexander E. Outerbridge, Jr. (J F I-March.) 1000 w.

Mining.

*29147. Gold Production in Colorado. W. C. Wynkoop (E Mag-April.) 1800 w.

*29162. Cast Iron Tubbing. Arnold Lupton (I C T-Feb. 1.) 2400 w.

*29163. The Valuation of Mines. Editorial (M J-Feb. 2.) 1400 w.

*29191. Underground Haulage.—Tail and Endless Rope System and Tipples for Handling Large Outputs. T. B. De Armit.—Read before the W. P. C. M. I. (C E-Feb.) 4800 w.

*29192. The Protection of Miners. Andrew Roy.—Read before the Ohio I. of M. E (C E-Feb.) 1500 w.

*29193. Phosphate Deposits in Algeria. Report of Charles T. Grellet (C E-Feb.) 700 w.

*29194. The Greater Safety to Life and Property in Coal Mining Secured by the Employment of Certificated Mine Foremen. Editorial (C E-Feb.) 1800 w.

*29221. The Legal Meaning of "Mines and Minerals." Anon. (C G-Feb. 1.) 5000 w.

*29223. Sinking Shafts by Congelation at the Auzin Colliery. (Extract.) M. Petit (C G-Feb. 1.) 1500 w.

*29224. The Coal Mines of Servia. From Report of A. Leveson-Gower (C G-Feb. 1.) 2000 w.

*29241. Gypsum. Anon. (I C E-Feb. 1.) 1200 w.

29250. La Plata Gold Region. Ill. A. Lakes (Min R-Feb. 8.) 2000 w.

29319. The Coal Supplies of Polk County, Iowa. Floyd Davis (E M J-Feb. 16.) 1600 w.

29321. Lake-of-the-Woods, Ontario, Gold District. Walter Douglas (E M J-Feb. 16.) 1000 w.

*29352. Explosives for Mining Purposes. (Abstract.) J. House (A M S-Jan. 5.) 1900 w.

*29353. Geology of the Mount Drysdale District. (N. S. W.) J. B. Jaquet (A M S-Jan. 5.) 1300 w.

29373. Monazite. Its Uses, Its Nature and Its Location. Anon. (T-Feb. 15.) 2500 w.

29374. The Minerals of the Appalachian. W. M. Brewer (T-Feb. 15.) 1200 w.

29397. South African Gold and Diamonds. Interview with B. Coulson Bunn (Min R-Feb. 15.) 2800 w.

*29412. The Importance of the Gwelo District of Matabeleland. Editorial (Min W-Feb. 9.) 800 w.

*29413. The Management of the Mysore Mine. Editorial (Min W-Feb. 9.) 1300 w.

29465. The Miner's Place in the World. Editorial (M I T-Feb. 14.) 1000 w.

*29466. The Dundar Gold Fields. Brenton Symons (M J-Feb. 9.) 1200 w.

*29479. The Working of German Coal Mines (C G-Feb. 8.) 700 w.

*29480. The Coal Industry of France. From the Statisque de l'Industrie Minérale (C G-Feb. 8.) 4800 w.

†29486. The Dolgourouky Copper Mines. Anon. (I E-Jan. 19.) 900 w.

29524. Dredging at Dayton. Ill. A. C. Robbins (M S P-Feb. 16.) 1500 w.

29525. The Great East Lode of California. W. H. Storms (M S P-Feb. 16.) 1800 w.

29526. Diamonds. Anon. (M S P-Feb. 16.) 2300 w.

29548. The Wall Rocks of California Gold Mines. W. H. Storms (E M J-Feb. 23.) 3000 w.

29550. The Mining Exposition at Santiago, Chile. Anon. (E M J-Feb. 23.) 1600 w.

29553. Park County Gold Mines. Ill. Anon. (M I T-Feb 21.) 1000 w.

*29599. Mining in Spain (Asturias) Anon. (M J-Feb. 16.) 1100 w.

*29601. The Concentration and Washing of Coal. Editorial (M J-Feb. 16.) 2000 w.

*29609. Electricity as Applied to Mining. G. S. Corlett (I & S-Feb. 16.) 5300 w.

*29621. Coal Mining in India. Extracts from Report of James Grundy (C R-Feb. 15.) 6600 w.

*29622. The Search for Coal over the East-

ern Boundary Fault of the South Staffordshire Coalfield (Abstract). T. G. Meachem (C G-Feb. 15.) 2500 w.

29645. Ancient and Modern Tin Mining, Wilkins Trick (Min R-Feb. 22) 1200 w.

29673. The Glendower Iron Deposit. W. G. Miller (C M R-Feb.) 2000 w.

29674. The Silver Mines of Thunder Bay. Peter McKellar (C M R-Feb.) 1300 w.

29675. Gold in Ontario and Its Associated Rocks and Minerals. A. P. Coleman (C M R-Feb.) 3500 w.

29677. A Few Notes on Merchantable Mica in the Laurentian. Ill. William Hamilton Merritt (C M R-Feb.) 1600 w.

*29739. Measurement of Water. Report of the Montana Society of Civil Engineers. A. M. Ryon (J A E S-Jan.) 3000 w.

*29751. Russian Coal Industry (B T J-Feb.) 1500 w.

29754. The Production of Precious Metals Since 1492 (E M J-March 2.) 700 w.

29755. The Australasian Gold Field of 1894. John Plummer (E M J-March 2.) 500 w.

*29800. More About the Gwelo District (Min W-Feb. 23.) 700 w.

*29831. The West Australian Gold Fields. Interview with the Well-Known Mining Expert, W. R. Fitzgerald Moore (M J-Feb. 23.) 3200 w.

*29833. Notes on the Espirito Santo Mines at Cana.—Its Drainage and Recovery. Ernest K. Woakes (M J-Feb 23.) 2000 w.

*29835. The Manganese Deposits of Huelva. Frank Johnson (M J-Feb. 23.) 1500 w.

*29836. The Recent Volume of Spanish Mining Statistics. Editorial (M J-Feb. 23.) 1800 w.

*29837. New Fields for Gold Mining. Editorial (M J-Feb. 23.) 700 w.

*29838. The Alabaster Industry. Extract from Report of Vice Consul Carmichael (A L-Feb. 22.) 3500 w.

29939. Pocket Mining in California. W. H. Storms (M S P-March 2.) 2000 w.

29942. Compressed Air as Used in Mines (Abstract) Charles C. Hansen (E M J-March 9) 1200 w.

29944. The Goler Gold Diggings. Frank L. Nason (E M J-March 9.) 1000 w.

Serials.

20413. Mining Methods. Ill. (C E-Began March, 1894—12 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March, 1894—12 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March, 1894—12 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March, 1894—12 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng-Began April 27, 1894—14 parts to date—30 cts. each).

22586. The Mineral Hydrocarbons (M S P-Began June 2—23 parts to date—15 cts. each).

22710. Science for Iron Mongers. By a Member of the Royal Inst. (Irm-Began June 2—16 parts to date—30 cts. each).

25689. A Typical Gold Mine Region—Description of Cripple Creek, Col. Ill. Arthur Lakes (C E-Began Oct.—Ended Feb.—5 parts—30 cts. each).

26386. Proper Foundry Construction and the Apparatus to be Used. Simpson Bolland (T-Began Nov. 1.—Ended March 1—7 parts—15 cts. each).

27329. Coal-Mining Economy Up to Date. Ill (I C T-Began Nov. 23—8 parts to date—30 cts. each).

27450. Cupola Tuyeres. Edward Kirk (Met W-Began Dec. 8—5 parts to date—15 cts. each).

28589. The Mineral Resources of Tasmania. A. Montgomery (A M S-Began Dec. 1—5 parts to date—30 cts. each).

28642. How Iron Is Made. Ill. John Birkinbine (F D-Began Jan.—2 parts to date—15 cts. each).

28736. The Mineral Wealth of Siberia (M J-Began Jan. 19—6 parts to date—30 cts. each).

28932. Cripple Creek Ore Deposits. Ill. Edward Skewes (E M J-Began Feb 2—2 parts to date—15 cts. each).

28975. Charbonnages Unis de L'ouest de Mons, Boussu, Belgium (C G-Began Jan. 25—Ended Feb. 1—2 parts—30 cts. each).

28978. The Iron Industry in the South of Russia. M. Paul Bayard (C G-Began Jan. 25—Ended Feb. 8—3 parts—30 cts. each).

28990. The Mining Industry as a Legitimate and Profitable Business. Milo H. Slater (M I T-Began Jan. 31—2 parts to date—15 cts. each)

29105. Diabese Dykes in the Sudbury Mining Region. T. L. Walker (C M R-Began Jan.—2 parts to date—15 cts. each).

29414. Hadfield's Steel Foundry. Ill. (E-Began Feb. 8—Ended Feb 22—2 parts—30 cts. each).

29468. The Cyanide Process.—Its Practical Application and Economical Results. A. Scheidel (M J-Began Feb. 9—3 parts to date—30 cts. each).

29495. The Composition and Constitution of Certain Alloys. C. R. Alder Wright (Sc A S-Began Feb. 23—1 part to date—15 cts).

29753. The Sampling and Measurement of Ore Bodies in Mine Examinations Edmund B. Kirby (E M J-Began March 2—2 parts to date—15 cts. each).

29815. Geology of the South East Portion of the Congo Basin and the Metalliferous Deposits of Katanza. Anon. (C G-Began Feb. 22—1 part to date—30 cts).

29817. Recent Developments in Coal Mining in Japan. Ill. Anon. (Eng L-Began Feb. 22—1 part to date—30 cts).

MUNICIPAL ENGINEERING

Sanitary Engineering.

THE JOURNAL OF THE FRANKLIN INSTITUTE for March prints a lecture delivered by Mr. Paul Gerhardt at the Franklin Institute (Feb. 15). The lecture presents an exhaustive view of this branch of engineering, which has been differentiated as a specialty in obedience to the modern tendency toward specialization in all the industrial arts and allied professions. The promotion of conditions which tend to decrease the death-rate and increase the health-rate of communities is the purpose of all works of sanitary engineering, as defined by Mr. Gerhardt, and "a general knowledge of architecture and of civil engineering should form the basis of the education of the sanitary engineer." Following this, there should be a general preparatory course in natural sciences and mathematics, in the principles of construction, in the stability of structures, in draughtsmanship, and in manual training, without all of which no engineer can attain eminence; and the student should learn the rudiments of engineering as relating to commerce, to agriculture, manufacturing industries, mining, building, and public health. The sanitary engineer should also study sanitary science and everything pertaining to public and individual health, including first aid to the injured in accidents or emergencies, so common in the actual practice of the engineer.

The water-supply of cities may have deficiencies in quality, quantity, or pressure; sewerage systems may be defective, and even the streets and pavements of a city may possess elements which are detrimental to health. It is the office of the sanitary engineer to discover and prescribe remedies for all such deficiencies. In the laying-out of new cities, as well as in improving the sanitary conditions of older municipalities, his counsel will be needed in preventing the adoption of unsanitary plans, and in the arrangement of streets, parks, and open squares in such manner as to promote both convenience for traffic and a high standard of health. The necessity of having plenty of public squares, parks, open spaces, and airing grounds in cities is explained, as well as the desirability of having rows of trees planted in the wider streets, all of which tend to increase the salubrity of a city by lessening street dust, removing street noises, maintaining a purer atmosphere, and affording playgrounds for children and opportunities for recreation to the working-people and the city poor. Water-fronts of harbor towns, or cities situated on the banks of rivers, should be beautified and improved, and not form, as usual in American cities, their least attractive portion. All natural water-courses traversing a city should be kept unpolluted, and none should ever be used as sewer outlets. The need of well framed building and sanitary regulations for all cities is pointed out, and the services which sanitary engineers can render in the enforcement of city ordinances is explained. The sanitary works mentioned form together a sanitary system of wide scope, which provides safeguards for the public health and secures general town sanitation. Other sanitary problems, like smoke prevention, city cemeteries, cremation, drainage of swamps, prevention of inundations and storm-flood, and the sanitary influences of forests, are discussed. The sanitation of the dwelling, the protection of buildings against the elements, the problem of housing the poor in large cities, the planning of hospitals, prisons, and military barracks, the necessity of establishing people's baths in populous city districts, the requirements of safety from danger of fire or panic in theatres and halls of audience, and other problems are not the least interesting part of the lecture. Industrial hygiene, including the prevention of machinery accidents, abatement of nuisances, regulation of offensive trades, and sanitation of summer resorts, railway cars, ferry-

boats, and sea-going vessels, are all touched upon.

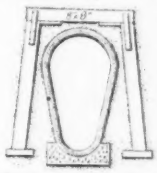
The lecture concludes with a brief allusion to the trades allied to sanitary engineering, and recommends that, "inasmuch as sanitary engineers are by the nature of their special training specially qualified and well-fitted to be identified with public matters, their profession should in the future be freely represented in boards of public works, of health, of education, of charities, as well as in city councils, city improvement societies, and citizens' committees."

Tunnelling through Quicksand.

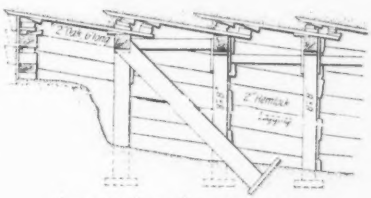
A LETTER addressed to *Engineering News* (Feb. 21) by Mr. Willard D. Lockwood, Jun. Am. Soc. C. E., is of general interest to engineers. As it is not long, we copy it entire.

"In the course of construction of the Goodman St. and State Hospital sewer at Rochester, N. Y., the contractors were obliged to drive a tunnel through a hill of quicksand about 500 ft. in length. As most of the work around Rochester has been in rock, the contractors were apparently afraid of the work. The contractor to whom the work was finally awarded went at it as well as he knew how, but at the end of a second month he found that his men had advanced only 100 ft., and that the men were becoming more afraid of the work every day, as bad cave-ins were very frequent, at times completely burying the men in the breast. The contractor thus found himself paying out double the money he would receive from the city, and was very glad to give a sub-contract to Mr. William Jones of Pittsburg (a man of long experience in soft-ground work) and the author.

"After we had looked the ground over, we decided to erect a simple builder's derrick over the shaft and use cars and flat skips. As the amount of material that would be removed from the breast in each shift was very small, the heading being 6 × 6 ft., we decided to work the derrick by hand, the muckers raising their own cars. We placed in charge of the work Mr. John Collins of Philadelphia, a soft-ground miner of unusually varied experience. As soon as Mr. Collins had got together miners for two shifts, he examined the breast, and found it in such bad condition that it took nearly a week to get in the first set of timbers. The ground being finally caught up, the miners felt more at ease and began their excavating, thinking that their trouble was over; but the next day, without the least warning, the breast came in with a rush, and, had it not been for the unusual care taken by Mr. Collins in placing his timbers in the breast, the men would all have lost their lives. After this inflow was removed, all went well for the next 100 ft., when a bed of boulders was encountered embedded in the quicksand, and, as it was impossible to think of



Cross Section of Finished Tunnel.



Longitudinal Section, Showing Methods of Timbering.

Constructing a Sewer Tunnel in Quicksand, Rochester, N. Y.

blasting with ever so light charges in such material, it was only by the slowest progress and utmost watchfulness on the part of the men that the danger was passed. At times the quicksand was almost as hard as rock in the breast, but at the same time it would come in instantly if given the least chance.

"The timbering in the breast was done with a center leg, and in some cases a false cap and raker, the completed work being tied up with stretchers. The timbers were placed about 4½ ft. c. to c., using 8 × 8-in. hemlock, with 6-ft. oak lagging 2-in. thick on top and 2-in. hemlock lagging for the sides. The lighting of the tunnel was

done entirely by candles, with a gasoline torch at the top of the shaft for the night shift.

"Even with the unusual precaution taken and the corresponding extra time taken in the start of each shift, the work was advanced on the average of 4½ ft. to a shift. The work was done with two miners in the breast and two muckers loading their own cars and raising them by hand to the dump. The shaft, being in a low place, was but 25 ft. deep. The men usually completed their day's work—that is, as a rule, one set of timbers—in seven to eight hours. The miners were paid $2.50 per day, and muckers $2. The work of driving and timbering the tunnel complete amounted to $5 per lin. ft.,—that is, $2 per ft. for timber, lights, and tools, and $3 per ft. for labor."

Tests of Cement Joints for Pipe Sewers.

THE JOURNAL OF ENGINEERING SOCIETIES for December was delayed (as we are informed by Secretary John C. Trautwine) by the preparation of the annual summary of the "Monthly Index to Current Engineering Literature," which comprises ninety pages. It reached us too late to be available for review in our March number. It contains a paper by Freeman C. Coffin, member of the Boston Society of Civil Engineers, which, under the above title, deals with a practical subject of importance to municipal engineers. The author ates the undesirability of the infiltration of ground water into sewer pipes w he the effluent is to be treated by infiltration after its discharge, on account of the increase of the volume of discharge to be treated. He also considers the infiltration of ground water undesirable in that it upsets the calculations by which engineers are guided in designing sewers, since "in a self cleansing sewer it is nearly as important to have the sewer small enough as to have it of sufficient capacity. It is well known that there is more or less leakage of ground water in all systems of pipe sewers, and in some cases it is a large percentage of the system. Undoubtedly this leakage is largely caused by the fact that it is difficult, if not impossible, to make joints in a wet trench. By a perfect joint I mean one that is completely filled all around with cement. This difficulty is greatly increased by the shortness of the length of pipe; and the narrowness of the joint room in the so-called standard form of joint adds to the difficulty of filling it with the cement mortar, especially when, as is often the case, the pipes are not concentric. It is customary to overfill these joints, making an angle of about 45° between the outside face of the cement and the side of the pipe. This assists in preventing the inflow of water, but, when the pipes are laid in a trench in which water is present, it is nearly impossible to keep the mortar intact until it is set. The shortness of the pipe—not exceeding 3 ft.—makes it very hard to dig a bell hole large enough

FIGS. 1 AND 2
FLUSH JOINTS.

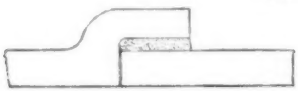


FIG. 1

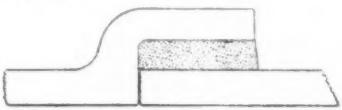


FIG. 2

FIGS. 1 AND 3. STANDARD SOCKETS.

FIGS. 2 AND 4 DEEP SOCKETS.

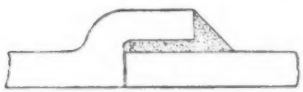


FIG. 3.

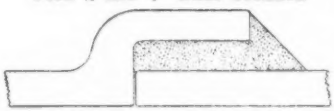


FIG. 4

FIGS. 3 AND 4
OVERFILLED JOINTS.

to work in and to provide for the suction of a pump, while still keeping the pipe in proper alignment; and the water cannot so well be dammed back while the joint is being made, as in a longer one, such as a water pipe. The Portland Stone Ware Co. has recently begun the manufacture of sewer pipes with wider and deeper sockets, under the name of 'deep-socket' pipe. The shape of this socket is shown by Figs. 2 and 4, and the standard socket is shown by Figs. 1 and 3. All four figures represent joints for 6-in. pipe. It is hoped that the use of these joints will facilitate the extension of better work. The city of Brockton has used the pipe in its new sewerage system. The following table gives dimensions of these joints from 4 to 24 in. diameter."

TABLE OF DEEP-SOCKET PIPE.

Size.	Depth of socket.	Thickness of joint room.
4	2 5-8 inch	5 8 inch
6	2 5-8 "	5-8 "
8	2 5-8 "	5-8 "
10	2 5-8 "	5-8 "
12	2 5-8 "	5-8 "
15	3 1-8 "	5-8 "
18	3 1-8 "	5-8 "
20	3 1-8 "	5-8 "
24	4 "	5-8 "

"While preparing for these tests, I had some apprehension that there might be no leakage in a perfectly-made joint under so light a pressure" (5 ft. head). "To have the tests of any value, it was necessary to make the joints in as uniform a manner as possible, and therefore as well as could be done, which it was comparatively easy to do with the pipe in a vertical position during the process. Under such conditions it seemed possible, if not probable, that there might be no measurable leakage, and therefore no means of comparing the different kinds of joints; but a consecutive record of the tests shows that, out of the sixty-three tests, only three failed to show leakage, and in these the leakage was not prevented by the use of cement alone."

The tests were carried out with Rosendale and Portland cements and different mixtures and appear to have been very exhaustive. A full description of the apparatus and methods of testing is given, with an illustration of the apparatus, and a table of results. The latter are decidedly favorable to the deep-socket pipe. Painting over the joints with asphalt varnish reduced the leakage very much. Mr. Coffin believes that leakage of deep-socket pipe joints may be reduced to 150 gallons per mile of 6 in. pipe per day of 24 hours, with proper care in laying it, and when neat Portland cement is used for making the joints, the pipe lengths being 2 ft.; but he recommends a trial of 3-ft. pipe lengths.

Water Gas From Bituminous Coal.

In a paper read at the annual meeting of the American Gas Light Association, and published in full in the *Gas Light Journal*, Mr. F. Egner presented a very thorough *résumé* of recent progress in making water gas. This product, as is well known, is formed by bringing carbonaceous material to an incandescent condition, and then passing steam through the mass, thereby decomposing both; afterwards the gas thus produced is either carburreted or not, with crude petroleum or some other liquid or volatile liquid hydrocarbon. The carbonaceous material is either anthracite coal or culm, bituminous coal or slack, or gas retort house coke. "In the early days of water gas," says Mr. Egner, "one of the objections urged against it was that bituminous coal could not be employed in its manufacture. Even retort house coke was pronounced by supposed good authorities to be altogether unsuitable for the purpose. . . . But it has been done; and now we know that good retort house coke, weight for weight, is better than anthracite for the purpose, and it is only a matter of cost which should be used." The author takes up the history of the attempts to use bituminous coal, describing early experimental plants, and gives a detailed account of a later successful plant at Chicago, operating on this system, having a capacity of 400,000 feet daily of fuel and illuminating gas, and using a bituminous coal which is not a gas coal. Details of construction of plant, methods pursued, cost, and comparisons are given in profu-

sion, with illustrations of generators. The figures quoted and the tone of the essay indicate a belief that there is a promising future for water gas made from bituminous coal.

MR. N. N. DAVIS says in *Fire and Water*, that the prime factor of any basis rate is fire protection. Water works constitute the most preferred fire protection, hence, control "basis rates," as is evidenced by the fact that towns and cities are classified as follows: First class cities or towns have a fully paid fire department, electric fire alarms adequate water works. Second class have volunteer, or partly paid fire department, and adequate water works. Third class have volunteer fire department, with steamers, but inadequate water supply (from cisterns or steamers), or hand engines and adequate watersupply from cisterns, etc., not water works. Fourth class have no adequate water supply nor fire department. This classification shows the chief conditions under which a risk is to be assumed in any town and indicate the economy of a well-equipped fire department.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Gas Supply

*29181. The Efficiency of Luminous Combustion. Harold B. Dixon (J G L-Jan. 29.) 3000 w.

*29182. A Plea for Gas Stokers. By a Country Manager (J G L-Jan. 29.) 2500 w.

*29183. Incandescent Lighting by Water Gas. (Abstract.) H. Strache (J G L-Jan. 29.) 900 w.

*29245. Interview with Dr. Dvorkovitz (G W-Feb. 2.) 3800 w.

29330. Municipal Ownership of Gas Works. Editorial (P A-Feb. 15.) 1300 w.

29331. Notes on Modern Gas-Making Plant. Working Up of Gas Liquor. Ill. G. Schimming (P A-Feb. 15.) 3500 w.

29343. Fuel Gas of the Future. J. A. Faux (A M & I W-Feb. 15.) 1800 w.

*29346. Acetyline and the Gas Industry. Norton H. Humphreys (J G L-Feb. 5.) 1400 w.

29378. Argument by the Hon. Henry C. Kelsey before the House Committee on Municipal Corporations of the New Jersey Legislature in Opposition to the Proposed Dollar Gas Rate for Certain Cities of that State (A G L J-Feb. 18.) 5500 w.

*29423. Testing of Incandescent Gas Burners. Tests of Professor Wedding (G W-Feb. 9.) 400 w.

*29424. The Efficiency of Carbon Vapor in Coal Gas and Other Hydrocarbon Flames, and Other Matters of Interest in the Manufacture of Coal Gas. (Extract.) Lewis T. Wright, with Discussion (G W-Feb. 9.) 4500 w.

*29460. Gas Testing in Street Culverts. Ill. Frank Clowes (El-Feb. 8) 1800 w.

*29523. The Trial of Oil-Gas Plant at the Bradford Gas Works.—Report on the Experiments with Dr. Dvorkovitz's Process (J G L-Feb. 12.) 1700 w.

*29567. From the Electric Furnace.—A Product of Interest to Gas Manufacturers. Anon. (E R L-Feb. 15.) 1800 w.

*29602. The Incandescent Gas Light for Use in the Optical Lantern. John A. Hodges (G E M-Feb. 11.) 1200 w.

*29603. The Determination of Tar in Gas. W. Leybold (G E M-Feb.) 1100 w.

29635. The Effect of the Introduction of the Welsbach Lamp on the Business of the Gas Company. Joseph E. Nute, with Discussion (A G L J-Feb. 25.) 1000 w.

29720. The Guide Framing of Gasholders. F. S. Cripps (P A-March 1.) 2000 w.

29722. The Proper Location of Gas Meters in Buildings. Samuel Abbott, Jr. (P A-March 1.) 800 w.

29724. Whose Make of Lighting Fixtures Shall We Recommend? W. M. Eaton (P A-March 1.) 1100 w.

29725. The Heating Effect of Artificial Lights. Henry W. Douglas (P A-March 1.) 800 w.

29762. Some Card Catalogues in Use for Record of the Outside Work of a Gas Company. S. J. Fowler, with Discussion (A G L J-March 4.) 4200 w.

*29767. The Detection of Poisonous Water Gas in the Air, and of Explosive Gas in Electric Culverts. Ill. Frank Clowes (J G L-Feb. 19.) 1500 w.

29778. Operation of Water Works with Gas Engines. Comments on Article by Max Muenzel (A M & I W-March 1.) 400 w.

29779. Proportional Scale for Mixture of Natural Gas with Rose-Hastings Manufactured Gas (A M & I W-March 1.) 600 w.

*29825. The Recovery of Bye-Products from Producer Gas. A. Gillespie (I & I-Feb. 22.) 2800 w.

*29863. On the Relative Values of Benzol and Carburine for Gas Enrichment. Lewis T. Wright (G W-Feb. 23.) 1800 w.

We supply copies of these articles. See introductory.

*29879. Inaugural Address of S. W. Durkin (J G L-Feb. 26.) 3500 w.

*29880. C. R. Bellamy on the Consumption of Gas for Lighting (J G L-Feb. 26.) 4000 w.

29545. Building a Sewer Tunnel in Quicksand. Ill. Willard D. Lockwood (E N-Feb. 21.) 500 w.

29699. The Sewerage System of Los Angeles, Cal. Ill. Burr Bassell (E N-Feb. 28.) 4800 w.

Streets and Pavements.

29252. Annual Report of the Massachusetts Highway Commission (G R-Feb.) 4800 w.

29379. Hard Material Sidewalks. Anon. (Municipality and County-Feb.) 1500 w.

†29489. Pyingado for Wood Pavement. J. Nisbet (I Eng-Jan. 16.) 1200 w.

29572. Recent Work of the Massachussetts Highway Commission. Ill. (E R-Feb. 23.) 3500 w.

*29792. Views of Practical Men on Paving Brick. Daniel W. Mead, with Discussion (P-March.) 4800 w.

*29793. The Testing of Clay Paving Material. Edward Orton, Jr., with Discussion (P-March.) 8000 w.

*29794. "Can Shale Paving Be Toughened by an Annealing Process in Burning?" William S. Williams (P-March.) 1500 w.

*29795. Elements of a Good Paving Brick.—Discussion (P-March.) 3500 w.

Water Supply.

29185. The Interpretation of Water Analysis. J. C. Thresh (A A-Feb. 9.) 1200 w.

29248. The Peterborough Water Works. Ill. A. C. McCallum (C Eng-Feb.) 2500 w.

29570. New Gravity Water Works, Portland, Ore. (E R-Feb. 23.) 1300 w.

29646. Metropolitan Water Supply.—Boston and Adjoining Places to Have a New System (F W-Feb. 23.) 1300 w.

29695. Specifications for Stand-Pipes. William D. Pence (E N-Feb. 28.) 11000 w.

29731. Economy of Water Works. N. N. Davis (F W-March 2.) 1000 w.

*29736. The St. Louis Water Works. Ill. I. Historical. M. L. Holman. II. Points of Interest in the Design and Construction. S. Bent Russell. III. New Machinery. John A. Laird. IV. Quality of the Supply. Robert E. McMath. V. The Filtration of City Water Supplies in the Light of Recent Researches. Robert Moore (J A E S-Jan.) 24000 w.

*29737. Tests of Non-Conducting Pipe-Coverings. Ill. John A. Laird (J A E S-Jan.) 600 w.

29780. The Proposed Boston Metropolitan Water Supply (E R-March 2.) 7700 w.

29930. The Proposed Boston Metropolitan Water Supply (E N-March 7.) 4200 w.

†29948. The London Water Supply. Major Greenwood (San-March.) 2200 w.

Miscellany.

*29146. Municipal Ownership of Public Corporations. M. J. Francisco (E Mag-April.) 3500 w.

*29151. The Control of Public Service Corporations. Allen Ripley Foote (E Mag-April.) 2500 w.

29332. Sanitation. Robert Morgan (Met W-Feb. 16.) 1500 w.

29359. The Parks and Proposed Parks of Washington City. Anon. (A A-Feb. 16.) 2300 w.

29437. Defacement of Parks in Buffalo. Editorial (G & F-Feb. 20.) 1200 w.

29522. Aeration as a Means of Purifying Sewage and Water. J. H. Curtis (E N-Feb. 21.) 2000 w.

29573. Recent Observations on Electrolysis, Brooklyn, N. Y.—From Report of John A. Barrett (E R-Feb. 23.) 2000 w.

*29643. London and Foreign Fire Brigades. Editorial (Eng L-Feb. 15.) 2000 w.

29670. The Care of Urban Parks. (Extract.) William McMillan (G & F. Feb. 27.) 1300 w.

†29685. Blackmail as a Heritage; or New York's Legacy From Colonial Days. Clarence Clough Buel (C M-March.) 10000 w.

†29686. I. Civic Self-Knowledge. II. The Cure for Municipal Corruption (C M-March.) 2400 w.

29697. The Granting of Franchises by Towns and Cities. Editorial (E N-Feb 28) 1600 w.

*29768. Water Supply and Sewage Disposal in Some Large European Cities. (Abstract.) J. S. Billings (J G L-Feb. 19.) 4200 w.

29891. City Engineers and Public Parks. Editorial (G & F-March 6.) 1400 w.

*29917. The Work of Village Improvement Societies. B. G. Northrop (F-March.) 4500 w.

†29949. The Collection and Disposal of Refuse and Garbage of Large Cities. (Extract.) W. F. Morse (San-March.) 4500 w.

Serials.

5358. Sewage Purification in America. Ill. (E N-Began July 14, 1892—44 parts to date—15 cts. each).

24751. The Gas Manager Abroad (G W-Began Aug. 25—12 parts to date—30 cts. each).

27636. The Economic Principles of the Gas Producer. Anon. (M W-Began Dec. 7—Ended Feb. 15—5 parts—30 cts. each).

28265. Frontinus on the Water Supply of Rome, A. D. 97. Clemens Herschel (E R-Began Jan 5—2 parts to date—15 cts. each).

28762. Filtration and Purification of Water. Ad. Kemna (I C B-Began Jan. 18—3 parts to date—30 cts. each).

28854. Water Purification. Rudolph Hering (J F I-Began Feb.—Ended March—2 parts—45 cts. each).

29316. Steel and Cast Iron Conduits. I. M. de Varona (F W-Began Feb. 16—1 part to date—15 cts).

29647. Water and Water Works. John W. Hill (F W-Began Feb. 23—2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

RAILROADING

Timber-Preserving Methods and Appliances.

A PAPER of more than usual interest upon this subject was read by Mr. W. G. Curtis, assistant to the general manager of the Southern Pacific Company (Pacific System), before the Technical Society of the Pacific Coast, December 7. *The Railroad Gazette* (Feb. 8) has published this paper in full, and those who desire the broadest information obtainable upon the subject are advised to read it. Only meager samples of its quality are possible here. Numerous illustrations help to elucidate the text. The author disclaims any intention to treat the subject exhaustively, confining himself strictly to a description of the process and portable plant used by the Southern Pacific Company, which, from the description, appears to be complete and convenient.

The experience of the Southern Pacific Company with zinc chloride for treating pine and fir ties has demonstrated that the process is economical. "One wood-preserving plant, having a capacity for treating about 2,500 ties per 24 hours, is amply large to burnettize all of the ties required for the Southern Pacific lines naturally supplied with ties from the pine and fir forests. The conditions are such, however, that to locate the plant at some station in the ordinary way would involve a very great cost for hauling the ties from delivery points to the wood-preserving works, and thence to point of use. The cost of four fixed plants, which would be required to reduce the cost of transportation to reasonable limits, was also out of the question. These difficulties led to the design of a portable plant, which was put into operation in June, 1894."

An illustrated description of this plant is given. "The plant comprises all of the appliances essential for creosoting, burnettizing, and all of the ordinary wood-preserving processes; one car carrying two steam boilers, steam winch, tools, wire rope, etc.; one car carrying superheater, measuring tank, force pump, air and circulating pump and condenser; two cars, each carrying three wooden supply tanks for holding the preservative fluid, each tank having a capacity of 24,000 gallons, and two retorts, each 6 ft. diameter by 114 ft. long, divided into sections, each section carried on two heavy car trucks. This plant, made up into a train of eight cars, made its initial journey from Sacramento, Cal., to Cornelius, Ore., 706 miles, last May, passing over 3.3 per cent. grades, and around the 14-degree curves of the Siskiyou mountains, without difficulty."

The arrangement of tracks, setting up of the plant, process of charging and handling ties, burnettizing treatment for railway ties, and the preparation of the fluid, are each separately treated. The process, as described by Mr. Curtis, comprises six steps. (1) "The charge is run in, and the heads or doors [of the retort] are closed up." (2) A preliminary vacuum is begun; this is to run up to about 20 in. During the vacuum the doors are bolted tightly. This vacuum process requires about 10 minutes. (3) Live steam is let in at about 30 lbs. pressure, and continued for about 4½ hours; it is then blown off, requiring half an hour. During this steaming and blowing off the retorts are drained. (4) A second vacuum is created, of from 22 to 26 in., which is maintained for about an hour. (5) The retort is filled with the zinc chloride solution, and pressure begun. This is continued until the required quantity of solution is injected into the ties. (6) The surplus preservative fluid is drawn off, the doors opened, and the charge pulled out on the platform. Another charge, which has in the meantime been made ready, is immediately pulled into the same retort to undergo the same process. The treated ties are unloaded onto adjoining cars, and the trucks are pushed to a small transfer table at the end of the platform, transferred to the opposite track of the same platform,

and loaded with fresh ties to be run into the other retort for treatment. Trucks sufficient for three charges of ties are used.

The time of treatment varies with the kind of timber treated and the length of time the ties have been allowed to season. In steaming, a pressure of about 20 lbs. per sq. in., corresponding to a temperature of about 260° F., is employed. The stock zinc chlorid solution contains 43 per cent. of zinc chlorid, 2 per cent. of impurities, and 35 per cent. of water. In use 27 lbs. of the stock solution per 100 gallons of water is the proportion employed.

The paper concludes with a description of the modes of testing the ties, and the records of charges, dates, durations, pressures, and temperatures for each charge, the latter being numbered for reference. In testing, borings taken from sample ties are separately "turned to an ash over a gasoline jet in a porcelain roasting-dish in contact with the air. The ashes are carefully collected in a platinum cup, and distilled water added, with a slight excess of hydrochloric acid, converting the zinc oxid into zinc chlorid. It is then filtered into a test tube, and the zinc hydrate thrown down with sodium carbonate, making a white floculent precipitate. The liquid is then made up with distilled water to 3 drachms. The resulting milky fluid is compared with standard liquids in tubes of the same size as the test tubes, each tube containing 3 drachms." This railway has found it economical to manufacture for itself the zinc chlorid used for burnettizing.

Balanced Locomotives.

In an article by Mr. Geo. S. Morison (*The Railroad Gazette*, Feb. 22) the balancing of locomotives is treated in a plain, common-sense, and convincing argument, in which the inadequacy of all pre-existing systems of locomotive balancing is clearly shown, and the final conclusion is reached that only in the four-cylinder compound locomotive has there been obtained a perfect balance at all speeds.

After briefly alluding to the attention recently paid to this subject, and a number of interesting discussions and papers which it has called out, the writer states the general problem to be solved in locomotive balancing. "Any mass of matter in motion tends to move at a uniform speed, except so far as retarded by external friction. The uniform rate of speed, however, is not that of any one portion of the moving mass, but of the center of gravity of the whole moving mass; if, therefore, the center of gravity changes as the mass moves, the motion of no one portion of the mass will be uniform, but will change as the center of gravity changes. In a locomotive every time a moving part changes its place, the center of gravity moves also, and the speed at which each part of the locomotive moves varies. As the connection with the train is not made with the center of gravity, but with the frame of the engine, the engine does not pull the train at a uniform speed, but with a speed that varies with every motion of the moving parts of the engine. In order to overcome this difficulty, counterbalancing is used, the counterbalancing being added in the form of weights in the driving wheels opposite to the cranks, so that, when the cranks move forward, the weights will move backward, etc.; by this method all revolving parts can be balanced with practical perfection, and the center of gravity kept constant. The moving parts, however, are not all revolving parts; the piston rods, cross-heads, and the forward half of the main rods have a reciprocal motion back and forth, and not a rotary motion; in other words, they disturb the center of gravity in a horizontal plane, but cause no vertical disturbance. If these reciprocating parts are balanced by revolving counterbalances, those revolving counterbalances can overcome the horizontal movement of the center of gravity, but will create a vertical disturbance of this center of gravity precisely equal to the horizontal movement which they balance. As, however, the horizontal movement is the one which creates an irregular pull on the draw-bar and gives a jerky motion to the engine and train, this horizontal disturbance is balanced, though at the expense of a vertical disturbance."

Within a few years a study of the wear of rails has shown that all the old methods

of balancing were defective, and that they permitted vertical disturbance, the effects of which were clearly indicated on the rails, and which were also indicated in other ways. "Reduction of the weight of reciprocating parts . . . . is admittedly a reduction, and not a cure. . . . The balanced compound locomotive meets this requirement by the use of four cylinders,—two high-pressure and two low-pressure; the high-pressure cylinders are placed outside the frames, and connect on crank pins. The crank pin on each side is placed directly opposite the axle crank on the same side, so that, while the high-pressure piston is moving forward, the low-pressure piston is moving backward, and the reciprocating parts of one balance the reciprocating parts of the other. On the other side of the engine the same arrangement exists, the cranks on one side being set on the quarter from those on the other, so that the four cranks are at right angles to each other." It is further shown that the use of large driving wheels is unnecessary with such locomotives, but that the system admits the use of "the small wheels which are needed to make quick starts, and yet can be run with perfect safety at extreme speeds between stations."

Boiler Covering.

THE subject of boiler covering as specially related to locomotive boilers is treated in a paper read at a recent meeting of the Northwest Railroad Club, and printed in the *Railway Age* (Feb. 15). The loss of heat from uncovered locomotive boilers is not determined, but from their exposure to winds and storms it is assumed to be far in excess of loss from an uncovered stationary boiler. The average loss from the latter has been determined to be 15 per cent.

In this country locomotive boilers are almost universally covered with "pine wood, sheathed with a jacket of Russia, planished, or common iron. Ten per cent. will cover the number of locomotive engine boilers in the United States that are covered with other material than wood. The ordinary method of applying wood covering is to secure it to flexible hoops encircling the boiler, leaving an air space between the boiler and the covering. It is generally admitted that, in order to obtain the best results, an air space between the boiler and the covering is necessary; but, in order to be effective, it should be practically air-tight, to prevent the circulation of air between the covering and the boiler. However, it is the practice at some shops to apply the wood lagging directly to the surface of the boiler with sheets of asbestos next to the boiler,—an advantage, as it assists in preventing radiation and the wood from charring. A coat of whitewash or plaster paris,—preferably the latter, as it is a good non-conductor,—applied to the shell of the boiler, prevents corrosion. The general practice is to omit covering the boiler head and the sides and front of a fire-box. Although this is done on some railways, it is the exception, and not the rule."

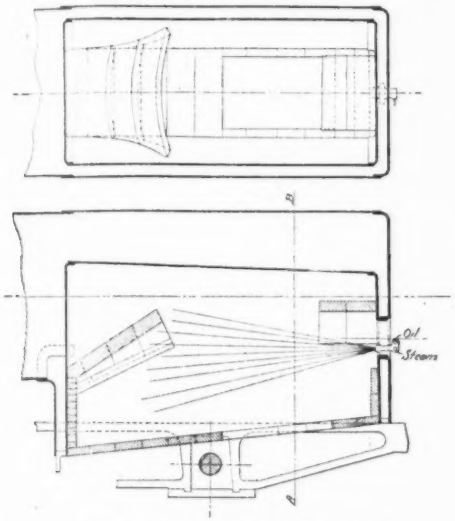
To lessen the difficulty and expense of lagging the sides of locomotive fire-boxes, plastic coverings are recommended. Many of these now in market are excellent non-conductors of heat, can be easily applied, and are reasonably durable in use. Coverings composed of hair, felt, or other organic fiber are objectionable for locomotives, and in general they are subject to decomposition when exposed to the action of high temperatures. "Wood covering is the cheapest, when we consider the first cost. For an eight-wheel locomotive, with a boiler 52 in. in diameter, the cost is: labor, $4.00; material, $7.10; total, $11.10. For the boiler of a consolidation locomotive, 60 in. in diameter, the cost is: labor, $6.75; material, $10.25; total, $17.00. Wood is undoubtedly the most costly covering, however, as it rapidly deteriorates by heat. All those in charge of locomotives doubtless realize the fact that we should have a boiler covering more efficient than wood to prevent radiation, and as readily applied and removed, and at a reasonable cost." Mineral fibre makes a good covering, but the sulphur sometimes contained in it is apt to attack iron more or less. On the whole, sectional composite coverings are considered as meeting the requirements more

fully than any others, but the first cost of such a covering would be from $65 to $80, or nearly three times as much as the maximum cost of the common wood covering.

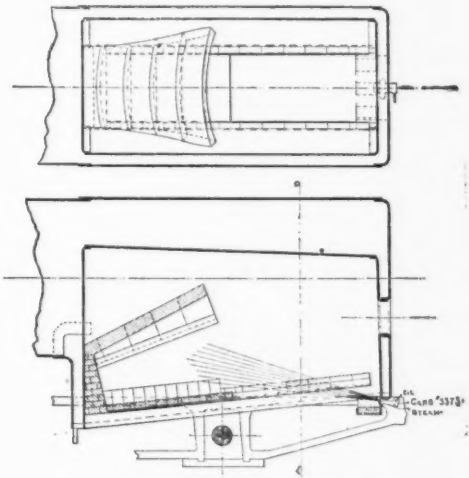
Oil Fuel for Locomotives.

RECENT experiments at the Baldwin Locomotive Works, directed to the utilization of oil as fuel for locomotives, are described in the *Railway Age* (Feb. 8), with illustrations herewith given. It is stated that the experiments were made on "what is considered the largest and worst type of locomotive,—compound No. 82, with 14-in. and 24-in. by 24-in. cylinders, and a long, narrow, and shallow fire-box.

"Two arrangements were made. In the first case (Fig. 1) the nozzle was in the place of the fire-box door. The grates were removed, and a 4-in. wall of bricks placed next the side sheets the whole length of the fire-box and at the ends. The bottom of the fire-box was covered over about half way back from the tube sheet and for about 18 in. at the back end. With this arrangement a trip was made from Philadelphia to Perkiomen junction, 25.7 miles, hauling a regular train. The engine burned the petroleum freely without smoke, and steamed freely, but, on account of frequent stoppages, it could not be tested for endurance. Another test was made, in which the burner was placed below the fire door, attached to the mud ring of the fire-box, as in Fig. 2. The line of spray was upward at an angle into the fire-box. The brick arch was lowered, giving more space between it and the crown-sheet. The bricks at the bottom were also removed, and a number of grate bars replaced. These were covered with fire-bricks. This arrangement was, by preliminary experiment, shown to be the best of all, and a final trip was made from Wayne junction to Port Reading, 52.3 miles, hauling twenty-seven cars, all but one loaded with coal."



OIL FUEL FOR LOCOMOTIVES. FIG. 1.



OIL FUEL FOR LOCOMOTIVES. FIG. 2.

The time occupied in making this run, including stops, was 3h., 20m., the actual running time being 2h., 48m., 9s. The water evaporated per pound of oil consumed was 10.58 lbs. The equivalent weight of water at 212° F. represented in this evaporation was 12.5 lbs. per pound of oil consumed. The oil burned per sq. ft. of grate surface was 132.25 lbs., or 39.68 lbs. per hour. The water evaporated per sq. ft. of heating surface per hour was 5.54 lbs., the equivalent at 212° F. being 6.55 lbs. An average steam pressure of 170 lbs. was

maintained. The train comprised twenty-six cars, weighing a total of 661 tons of 2240 lbs. From the results of the tests it has been concluded that a safe rule would be to give 1 in. in width of burner to each sq. ft. of heating surface.

Forfeiture of Charter.

THE decision of Judge Gaynor as to the obligations of railway companies to maintain their service regardless of the fact that they are unable to engage employees at some prescribed rate of wages has been variously received, according to various interests and prejudices. We did not understand the language of that decision to mean that there could be no legal excuse whatever for the cessation of service by a railway corporation, or that an effectual obstructive interference of a mob with an honest effort to operate a railway would not be such an excuse. The decision did say that the simple fact that men could not be employed at wages which the corporations were willing to pay was not enough to justify an interruption of traffic, the first duty of the companies being to the public, and the interests of the stockholders being secondary to this paramount obligation. We do not think this position can be successfully assailed.

Mr. R. D. Fisher in the *Street Railway Gazette* (Feb. 9), however, interprets Judge Gaynor's decision as applying to the "inability to operate street railways on account of mob violence occasioned and participated in by organized strikers and their sympathizers." He says:

"It is apparent from the temper of the people and the tendency of the times that it would be impossible to operate any railroad in this country, were the law to be rigidly enforced that a road must forfeit its charter if, even for a given number of hours, it failed to run its cars. Such a law would place such companies at the mercy of strikers, and such a ruling would be fallacious, unwarranted, and of such strange legal blindness as to occasion friends of law and order extreme anxiety. Seldom has this popular dislike been more flagrantly reflected from the bench in an attempt to deprive a corporation, operating under a public franchise, of its legal rights. If courts hold that a street-railway corporation, operating under a public franchise, cannot contract for its labor like any other employer, but, instead, must pay what its employees demand, no matter at what sacrifice, lest its service to the public should be impaired, few persons would care to invest money in a plant secured by a public franchise."

We do not believe there is a judge living who would thus interpret the law. Certainly the quotation grossly misrepresents the decision in question. The latter nowhere disputes the right of corporations to contract for labor on the same basis as an individual might do. But, if railways refuse the demands of their employees, and obstinately refuse any concessions, and organized labor refuses longer to work under terms hitherto accepted, the companies must be ready to promptly continue the public service in a reasonably adequate manner, without the help of its former force. This interpretation of the law of corporations has not the slightest relation to mob rule, and does not justify what Mr. Fisher says in the remarks above quoted.

Again he says: "To hold that, if a company cannot secure employees at prescribed wages, it is bound to secure them at any price in order to operate its cars is a most unfortunate utterance from the bench." Why unfortunate? Has a company the right to take the opposite course, and, unless it can get help at any price it chooses to name, refuse to operate its cars indefinitely, regardless of the interests and convenience of the public it has undertaken to serve? Where is the middle ground between these alternatives? A railway company is a public servant. It has contracted to perform certain duties to the public, in consideration of certain privileges the public has granted to it. If it breaks its contract, shall not the public have the same right that an individual would have under similar circumstances to declare the contract void through failure of one of the parties to meet the requirements of the agreement? Or are the terms of a contract by and between a railway corporation and the State binding upon the State only?

The public already has enough to fear from the encroachments of badly managed corporations without such a strained construction of existing statutes, however agreeable it might be to the companies. The history of judicial action with reference to railway corporations proves that railway companies have no more to fear from judicial utterances than the public has, or is likely to have.

The Brott Electric Bicycle Railway.

FROM New York to Washington in eight hours is the speed proposed by the promoters of this scheme. *The Inventive Age* puts it as follows: "Rapid transit with more speed than the hurricane, the birds of passage, or the proposed air ships, is what is stipulated in the bill now pending in congress, which incorporates a company to construct this bicycle railway from the capital of the nation to the city of New York, the commercial and financial center of the country." This burst of eloquence recalls to memory the rhetoric with which arguments in favor of the Boynton bicycle railway have been presented. It is fair to say, however, that, with electricity as the motive power, the bicycle railway system becomes much more feasible than with steam locomotives,—a fact alluded to on page 172, Vol. VIII, of this magazine. But, when a speed of 120 miles an hour is proposed, it makes one draw a long breath. Some unforeseen difficulties, we opine, will have to be overcome before such a speed can be maintained on a railway of this length by any kind of motor yet in existence. This speed implies a velocity of 176 ft. per second, at which a body moving directly upward would move against gravity, and without further application of power, through a further distance of 100 ft. In other words, it is very closely the velocity at which a body falling freely would acquire in 5½ seconds. A sudden stoppage, when running at this speed, would produce effects hitherto unprecedented in the history of railway accidents. But it is perhaps possible to so construct railways and machinery as to render accidents highly improbable and of extremely rare occurrence, and, after all, it is better to be killed outright than to be half-killed and linger out a miserable existence afterwards. The electric bicycle railway may become a fact, but we do not expect to live to see cars running at 120 miles per hour by any now-known mode of propulsion.

IN describing a new tubular frame car, *The Railroad Car Journal* assigns as the reason for the prevailing unpopularity of this class of cars with railroad men, the difficulties of repairing wrecked cars. This reason will appear to the lay mind both grim and humorous.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

29110. Timber Preserving Methods and Appliances. Ill. W. G. Curtis (R G-Feb. 8.) 4000 w.

*29144. Economy in Railway Operation. L. F. Loree (E Mag-April.) 4000 w.

29186. Forfeiture of Charter. R. D. Fisher (S R G-Feb. 9.) 1800 w.

29227. Test of Fuel Oil for Locomotives at the Baldwin Locomotive Works. Ill. (R A-Feb. 8.) 600 w.

*29244. The Light Railway Conference. —Recommendation for Legislation (Tr-Feb. 1.) 3800 w.

29257. A New Tubular Frame Car. Ill. Church and Ettenger (R C J-Feb.) 1600 w.

29258. Electrical Car Heating. George Huyter (R C J-Feb.) 500 w.

29259. Some Past Experiences, Present Problems, and Future Prospects of the Railroad Car Painters' Trade. Charles E. Copp. Read before N. Eng. R. R. Club (R C J-Feb.) 3000 w.

29260. The Diamond Pressed Steel Bolster. Ill. (R C J-Feb) 1200 w.

29261. Some Views on Legislative Interference with Rates. L. S. Coffin (R R-Feb. 9.) 1500 w.

29264. The Railroad Stationer. Editorial (R R-Feb. 9.) 1000 w.

29266. The Gas Motor Street Car in Service. Report of Frank H. Mason (E R N Y-Feb. 13.) 2000 w.

29268. Low Rail Joints of Street Railways and their Prevention. N. S. Amstutz (E N Y-Feb. 13.) 2300 w.

29308. The Brott Electric Bicycle Railway.

We supply copies of these articles. See introductory.

—One Hundred and Twenty Miles an Hour Between Washington and New York. Ill. (I Age-Feb.) 900 w.

29309. The Possibility of High Speed Railways. F. L. Averill (I Age-Feb.) 1300 w.

29312. Massachusetts Railroad Commissioners Report (R G-Feb. 15.) 1200 w.

29313. The Law of Standing and Voting Trusts. Editorial (R G-Feb. 15.) 2100 w.

29314. The Advantages of Large Grates. Editorial (R G-Feb 15.) 2300 w.

†29347. The Madras Railway. Editorial (I E-Jan. 12.)800 w.

*29354. Victorian Coal and the Victorian Railways. Quid Nunc (A M S-Jan. 5.) 3000 w.

*29366. The Stores Department of the North British Railway. Ill. A. E. Lockyer (R W-Feb) 2000 w.

*29367. London Suburban Tank Engines. Ill. (R W-Feb.) 1800 w.

*29368. American Express Locomotives. Ill. Clement E. Stretton (R W-Feb.) 1200 w.

29370. Examination of Motormen and Conductors for Sight and Hearing. Wheelock Rider (S R G-Feb. 16.) 800 w.

*29381. Overhead Construction in Chicago. —Not How Cheap, But How Good. Ill. (S R R-Feb.) 2000 w.

*29382. The Middletown Goshen Traction Company. Ill. (S R R-Feb.) 1800 w.

*29383. Some Early Types of Track Construction. Ill. (S R R-Feb.) 700 w.

29395. Sunday Trains. L. S. Coffin (R R-Feb. 16.) 1000 w.

29396. Boiler Covering. E. A. Williams (R A-Feb. 15.) 1200 w.

29402. The Constructive Features of Transmission Lines. Ill. Arthur Vaughan Abbott (E E-Feb.) 11700 w.

*29419. Light Railways and Parliament. Editorial (E-Feb. 8.) 3000 w.

*29458. The Light Railway Question.—The Decauville System (Tr-Feb. 8.) 3000 w.

*29462. The Commercial Value of Electricity, as Applied to Tramways. By a Tramway Engineer (Eng L-Feb. 8.) 1700 w.

29519. The Macpherson Switch and Movable Frog; Canadian Pacific Railway. Ill. (E N-Feb. 21.) 1200 w.

29521. Reasonable Railway Rates. Editorial (E N-Feb. 21.) 2000 w.

29539 The Class "P" Locomotive and the Pennsylvania Railroad. Ill. With Editorial (R G-Feb. 22.) 1800 w.

29540. The Rotary Snow Plow on the New York Central (R G-Feb. 22.) 800 w.

29541. A Report on a Balanced Locomotive. Ill. George S. Morison (R G-Feb 22.) 1800 w.

29542. Railroad Renewals. Ill. Joseph O. Osgood. (R G-Feb. 22.) 1000 w.

29543. The Pacific Railroad Debt. Editorial (R G-Feb. 22) 1800 w.

*29593. Underground Railway in London. A. E. Daniell (Ch-March) 2800 w.

†27595. Rail-Bonding and Its Bearing on Electrolytic Corrosion. Ill. George P. Low (T A I E E-Feb.) 4800 w.

29613. The Recent Blizzard.—Snow Fences and Snow Plows. Zero (R A-Feb. 22.) 1400 w.

*29626. Light Railways. W. M. Acworth, with Discussion (J S A-Feb. 15.) 12800 w.

29653. Railway Earnings and Income. Report of Henry C. Adams (R R-Feb. 23.) 1600 w.

29654. Notes on Culvert Pipe. Ill. Julien A. Hall (R R-Feb. 23.) 1500 w.

29655. Excessive Train Service. Editorial (R R-Feb. 23.) 1000 w.

29656. Reduced Rates as a Factor in the Increase of Traffic. Editorial (R R-Feb. 23.) 1200 w.

29657. A Sensible View of the Pacific Railroad Question. Joseph Nimmo, Jr. (R R-Feb. 23) 2400 w.

29658. The Kalamazoo New Railway "Safety." Ill. (R R-Feb. 23.) 1100 w.

29659. Railway Time Cards. Clement E. Stretton (R R-Feb. 23.) 900 w.

29661.—$1. The Pacific Railway Debts. R. T. Colburn (An A A-March.) 6000 w.

*29668. The Comparative Conditions and Cost of Transport by Railway and Canal. J. Stephen Jeans (I C T-Feb. 15.) 3000 w.

29684. Mountain Railways. Abstracts of papers by S. J. Berg, Alfred Collett and C. A. W. Pownall (Ir Age-Feb. 28.) 2200 w.

29696. Best Form of Draft Sheet for Fuel Economy in Locomotives. Ill. (E N-Feb. 28.) 1300 w.

29705. A Formula for the Maximum Train Load. L. G. Haas (R G-March 1.) 600 w.

29706. How to Live Without a Pool. Editorial (R G-March. 1.) 2000 w.

*29728. Petroleum for Locomotive Fuel. With Letter from James Holden (N C B-March.) 1800 w.

*29729. Adding Larger Boilers to Old Locomotives. With Letter from Francis R. F. Brown (N C B-March.) 1000 w.

29735. The Railroad Problem. Editorial (T-March 1.) 1300 w.

*29738. The St. Louis Extension of the St. Louis, Keokuk and Northwestern Railroad. Ill. B. L. Crosby (J A E S-Jan.) 7500 w.

*29756. The Electric Street Railway of Budapest.—An Object Lesson for American Cities. Ill. Anon. (R of R-March.) 1300 w.

29763 Needed Restrictions upon Electric Railways. Editorial, with Extracts from Report of the Connecticut Board (R A-March 1.) 1100 w.

29773. Suggestions for Street Railway Regulation in Brooklyn.—Report of Committee (S R G-March 2.) 900 w.

*29774. Possible Sources of Fuel Economy in Locomotives. Editorial on Mr. Forsyth's Paper. (A E R J-March.) 3000 w.

We supply copies of these articles. See introductory.

†29783. The Street Railway System of Buffalo. Ill. (S R J-March.) 4000 w.

†29785. The Manufacture of the Modern Electric Car Wheel. Ill. P. H. Griffin (S R J-March.) 3000 w.

†29786. The Snow and Wreckage System of the Chicago City Railway Company. Interview with M. K. Bowen (S R J-March.) 2000 w.

†29787. The Rail Joint Problem. Ill. C. E. Mark (S R J-March.) 1000 w.

†29788. Method of Patching a Heavy Split Gear. Ill. Devised by Robert J. Hill (S R J-March.) 400 w.

†29789. Novel Power Station Construction, Columbus, O. Ill. (S R J-March.) 2400 w.

†29790. Prospects for Cable and Electric Traction in England. Alexander McCallum (S R J-March.) 1000 w.

*29796. The Future of Electric Traction in This Country. Ill. Philip Dawson (E R L-Feb. 22.) 1700 w.

*29801. Indian Railway Extension. Editorial (R'y T-Feb. 23.) 1300 w.

*29808. The Economy of Colonial Railway Management. Editorial (E-Feb. 22.) 3000 w.

*29813. American Rail and Tram Ways. Jeremiah Head, with Discussion (C G-Feb. 22.) 3800 w.

*29816. The Life of Railway Axles. Thomas Andrews (Eng L-Feb. 22.) 2500 w.

*29822. Light Railways. Arthur C. Pain, with Discussion (Eng L-Feb. 22.) 5000 w.

29841. An Open Letter and Reply Concerning Track Bolts. Letter—Jerry Sullivan. Reply—J. N. Barr (R R-March 2.) 900 w.

29842. National Arbitration Bill, with Editorial (R R-March 2.) 2600 w.

29843. "Hole in the Wall"—Interlocking Installation, Victoria Terminus, London. Ill. (R R-March 2.) 900 w.

29844. A Wrecking Outfit. Extract from paper by W. L. Derr (R R-March 2.) 1100 w.

†29882. Railway Passenger Fares. Editorial (I Eng-Feb. 2.) 1200 w.

*29903. Car Lubrication. B. Haskell (L E-March.) 2500 w.

*29904. Loose Methods in Purchasing Coal. Editorial (L E-March.) 1200 w.

*29905. The Fuel Record Farce. Editorial (L E-March.) 1200 w.

*29906. Broken Rails. Joseph Anthony (L E-March.) 2800 w.

*29907. Some Things to Consider in Changing the Rules of Interchange (L E-March.) 1700 w.

*29908. Lubricators. George Royal (L E-March) 1800 w.

29928. Test of a New Design of Electric Railway Power Station. George W. Colles, Jr. and Edward B. Gallaher (E N-March 7.) 6600 w.

29929. State Regulation and Valuation of Railways in Texas. Editorial (E N-March 7.) 2000 w.

29931. Logging Roads. Editorial (E & C-March 1.) 1500 w.

29932. The Weaver Grate. Ill. (R G-March 8.) 2500 w.

29933. The Rules of Interchange (R G-March 8.) 600 w.

29936. Train Resistance, with Editorial R G-March 8.) 2000 w.

Serials.

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (R E M-Began Dec., 1893—13 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M-Began Jan. 1894—11 parts to date—15 cts. each).

24586. Railway Companies and Their Employés. O. D. Ashley (R A-Began Aug. 24—9 parts to date—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R-Began Aug. 25—26 parts to date—15 cts. each).

27850. What Street Railways Can Learn from Steam Railroads (S R R-Began Dec.—2 parts to date—30 cts. each).

28138. Block Signalling. Ill. W. H. Elliott (L E-Began Jan.—3 parts to date—30 cts. each).

28304. Signals and Signaling. Ill. (R R-Began Jan. 5—7 parts to date—15 cts. each).

28496. Electric Traction. Philip Dawson (E-Began Jan. 4—7 parts to date—30 cts. each).

28632. Light Railways. W. M. Acworth (P Eng-Began Jan. 11—Ended Feb. 1—4 parts—30 cts. each).

28897. Motor Repairs. Ill. W. E. Shepard (S R J-Began Feb.—2 parts to date—45 cts. each).

29109. The Systematic Improvement of the Lake Shore and Michigan Southern Railway. Benjamin Reece (R G-Began Feb. 8—2 parts to date—15 cts. each).

29175. On Electric Cable Railways. Ill. C. S. Du Riche Preller (E-Began Feb. 1—2 parts to date—30 cts. each).

29369. Tramway Management. By a Manager (R W-Began Feb.—1 part to date—30 cts).

29377. A Method of Permanently Protecting Underground Pipes from Electrolytic Corrosion. Harold P. Brown (A G L J-Began Feb. 18—Ended Feb. 25—2 parts—15 cts. each).

29384. Street Railway Wheel Threads and Flanges. Is a Standard Desirable? Anon. (S R R-Began Feb.—1 part to date—30 cts).

29667. An Australian Record of Railway Economy. Editorial (I C T-Began Feb. 15—2 parts to date—30 cts. each).

29775. Yard Arrangements Along Heavy-Traffic High Speed Railroads. A. Flamanche (A E R J-Began March—1 part to date—30 cts).

29840. Travels of the World's Transportation Commission. Clement F. Street (R R-Began March 2—1 part to date—15 cts).

29881. Light Railways. J. Walwyn (I Eng-Began Feb. 2—1 part to date—45 cts).

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

University Education for Engineers.

VERY seldom is a lecture dealing with an educational subject so filled with strong meat, so spiced with humorous similitudes, and so flavored with literary merit as is one entitled "The Broader View," recently delivered by Mr. G. W. Dickie before the engineering students of Stanford University, and printed in full in *The Sibley Journal of Engineering*. The selection of any part of this lecture for quotation seems a slight to every other part, all being of value and interest. Yet we must do this, or abandon the purpose of reviewing one of the soundest, most helpful addresses to engineering students we have ever met with.

The lecture starts out with the broad proposition that men cannot be taught to be engineers. "No professor of engineering, no matter how wise a teacher he may be, can do that. They can teach you a great many things that is very important for an engineer to know, but, in acquiring all knowledge possible from the physical and scientific investigations made in the laboratory or lecture-room, do not forget that it is not so much what you know, but what you do, that will make you an engineer."

In speaking of the disappointments suffered by graduates in their first efforts to take their places in the active actual work of the period, it is shown, however, that the university course is not regarded as of small value because it cannot alone make successful engineers. "It is hard for the university graduate who enters an industrial establishment to feel his carefully-acquired stock of exact knowledge is not the commercial article, and is not held in very high esteem by those with whom he now associates. The head draughtsman under whom he works may be entirely innocent of the knowledge that he has acquired. He may even use bad grammar in his explanations of the work in hand. In every point taken separately, he, the university graduate, may be the superior of those far above him as an engineer; and he is apt to feel that his training is all mistake, and is a hindrance instead of a help. But as his power of comprehending the nature of things grows and develops with the experience that comes through the practical application of the principles and laws he learned the nature of as a student, he will find that the time spent at his university will continually grow in importance as he himself advances."

Of the designs made as exercises in the course for educational purposes it is said: "Yet, after all this care and calculation, you are surprised to find, on comparing this ideal design with what is accepted as the best practice in machinery to perform the same functions, that there is little or no resemblance between them, and the great danger to you lies in the tendency to a conclusion in your mind that the reason of this difference is entirely due to the ignorance of the practical engineer whose designs are so confidently accepted by his clients." This is a saying which may well be pondered carefully by all students of engineering, as cautioning them against the error into which they are most likely to fall at the commencement of their active career,—an error which in some cases unfortunately persists to the permanent injury of many a young man who otherwise might have risen rapidly in his profession.

Here is another wise caution. "The mechanical student, in producing a machine design from his calculations of what each part should be, is likely to find a 'machinikin' as the result. In such condition work is not ready to be shown in public. It would be an indecent exposure of the design to show it thus. Get some clothes upon it. Look up the works of the best masters in the same line of mechanism. Try to comprehend why their work is so

unlike yours. Leave your figuring for a little while, and take a general view of what others have been led by experience to adopt. This will not, of course, give you experience, but it will remove from your mind some conditions that may very much delay your chance of acquiring experience, and it will enable you to go back to your design and fit a decent dress upon it, so that it may make a creditable appearance in mechanical society. . . . Another faculty of great importance to the engineer is that of being able to get most out of his eyes. An old foreman with whom I worked when a young man, when asked for instructions in regard to filling in work between two fixed points, was in the habit of saying: "Make it eye-sweet, my son, make it eye-sweet." I thought at the time that it was simply a habit that the old man had fallen into, but I have learned better since."

Finally, as to the real value of university training, Mr. Dickie takes a leaf from his own experience. "Some parts of what I have been saying might be taken to mean that I had but little faith in university training for the engineer. Such a conclusion would be a great mistake, and I would much rather not have addressed you than to leave such an impression on your minds. I would give a great deal to-day to be able to say that I had the advantage of a university training in the science of engineering. Many times I have struggled painfully through an engineering problem involving the use of, to me, intricate mathematical equations that to you would be very easy work, and I have wasted years in gathering up unaided only fragments of what you should have the whole of when you graduate from this institution. What I have gathered has been only what was absolutely necessary to meet my wants as an engineer, and many a time have I had to go hungry for the knowledge that would have lightened my labors. I am therefore not only in favor of the present course of engineering as given in the universities, but of extending it, and making it broad enough to embrace more practical work. Above all, I would like to see the students come from universities with clear ideas as to the practical application of the principles and laws that underlie all kinds of engineering construction."

Argon, the New Element.

IN this department for February mention was made of the supposed new element existing in the air, recently discovered by Lord Rayleigh and Prof. Ramsey. The papers read before the Royal Society on January 31, upon this gas, to which the name "argon" has been given provisionally, have attracted world-wide attention, and the subject is now under active discussion in scientific circles. *Nature* (Feb. 7) accepts the discovery as valid "beyond doubt or question." So does *The Engineer* (London, Feb. 8). *The Electrical Review* (Feb. 8), on the contrary, regards the existence of a hitherto unknown substance in the atmosphere as yet in doubt, and it gives a very good reason for doubting. In fact, there are several very puzzling things about argon, if we admit that there is such a substance, and perhaps some of our hitherto accepted theories will now have to be revised. The evidence of its existence seems convincing to us, notwithstanding the scepticism still remaining in some quarters. However, we have learned to respect scepticism in matters of science, and cannot approve the following criticism from *The Engineer* directed at those who had the temerity to doubt the existence of argon upon the first announcement made at the meeting of the British Association at Oxford: "Those who, with a temerity not according to knowledge, were hasty in belittling with shallow, half-baked criticism the original pronouncement of two observers, honest, competent, and candid, are reduced to the silence which would have befitted them at first." With all respect, we deem this criticism ill-judged. *The Electrical Review*, as above intimated, makes it plain in the following quotations that there is evidence against, as well as for, the existence of argon:

"The large, distinguished, and unprecedented meeting of the Royal Society of January 31 received the paper on 'Argon: A New Constituent of the Atmosphere'

with enthusiasm; and, although so many eminent personages were there, the absolute failure of the faculty of criticism on that occasion forms one of the most curious episodes in the history of the Royal Society of London.

"The facts as up to the present time disclosed by Lord Rayleigh and Prof. Ramsey are as follows: the weight of a liter of atmospheric nitrogen at 0° C. and 760 mm. barometric pressure is 1.2572 grammes. The weight of a liter of nitrogen derived from niter or ammonia is 1.2505 grammes. The theory by which Rayleigh and Ramsey seek to explain this difference of 6.7 milligrammes between the weights of atmospheric nitrogen and of the nitrogen derived from niter is that the presence of argon in the atmosphere is the cause.

"Let us now see how far the experimental evidence bears out this theory. Argon, say its discoverers, is heavier than the nitrogen of niter, the relative weight of equal volumes of argon and nitrogen being 20 and 14. That is to say, one volume of argon weighs very nearly as much as one and a half volumes of nitrogen. Now, in order that the excess of density of atmospheric nitrogen over niter-nitrogen may be accounted for, the amount of argon in atmospheric nitrogen must reach 1 per cent. by volume. Indeed, in strictness, a little more than 1 per cent. is demanded. According to Rayleigh and Ramsey, metallic magnesium possesses the property of combining with nitrogen at a bright red heat, and of refusing to combine with argon; and, by taking advantage of this property, they have brought out a method for the preparation of argon from air. In their paper they give instructions how to prepare argon by that method, and (what is more to the point) an example indicating the yield. They seem to have operated upon 100 or 150 liters of air, or, rather, of air from which the oxygen had been removed by red-hot copper in the well-known manner. In the actual experiment (the details of which they publish) the yield of argoniferous nitrogen was about 1500 c. c., which, of course, would be about 1 per cent. of the original atmospheric nitrogen. But now comes the remarkable fact: on further investigation, this 1½ liters did not turn out to be, approximately, pure argon. It was not even strongly argoniferous; it dwindled down to 200 c. c. on further treatment with metallic magnesium, and the 200 c. c. had a sp. gr. of 16.1, instead of 20, showing that only 70 c. c. was real argon. Thus actual experiment indicates that the real proportion of argon in the air is only about 0.05 per cent. by volume; and we are driven to the conclusion that the difference of density between the nitrogen of the air and the nitrogen derived from niter cannot be explained by the existence of argon in the air in the small proportion indicated by the actual extraction of the argon.

"Chemists with much practical experience in original research always attach importance to the yield of the new substance, and in cases where, as in the present instance, the yield of the new substance is only about one-twentieth of that which the theory requires, are inclined to regard the whole investigation with suspicion."

There are other reasons for doubt not given by *The Electrical Review*. *Nature*, notwithstanding its positive assertion of belief, above quoted, says: "Seldom have a series of facts and figures raised more important issues. The ratio of the specific heats" (under constant pressure and under constant volume) "is 1.66, which points to the conclusion that the substance is monatomic. If it is monatomic, it must be an element or a mixture of elements. If it is a single element, its atomic weight must be about 40, and in that case no place is ready for it in Mendeleeff's table. The easiest way out of the difficulty is to suppose that argon is a mixture" . . . etc. So it appears there are other theoretical points which may lead to doubt. Yet, if argon be truly a fact, the quotation from *The Engineer* which follows expresses the attitude which the scientific world must assume towards the discovery. "Nevertheless, belief in its validity must not induce any glossing of facts or straining of interpretation. In science the ascertained, experimentally-verified fact alone is sacred and permanent. Hypotheses—'laws' the

unwise call them—are as but the dust of the balance when a fact is on the opposite pan; but be sure it is a fact. Recent as its introduction is to the society of recognized elements, argon is already the subject of the paralyzing inquiry: 'What is the use of it?' Let us say at once, and unmistakably, that there is no use for it, nor is there likely to be. The cynic philosopher, parodying Lord Melbourne's deathless remark anent the Garter, would say that one of the chief advantages of argon is that 'there's no d——d utility about it.' Without adopting this impregnable position, we are content to remark that any possible application that may, in spite of its exceeding inertness, be found for argon can scarcely be looked for within six months of its original isolation. A host of keen workers will doubtless turn to its investigation in all possible directions, and, if utility is to accrue, it will be arrived at in due time by their exertions."

Rain-Making.

IT seems indeed remarkable, after it has been so thoroughly demonstrated that water is not precipitated from air unless the latter is at the point of saturation corresponding with its temperature, or is brought into content with some substance whose chemical affinity for water is greater than that of the air, that artificial rain-making should yet be deemed a possibility, and that a railroad corporation of hard-headed business men should be tempted to spend money in rain-making experiments. No doubt there is much need for a greater supply of water along the line of the Chicago, Rock Island & Pacific Railway. The locomotives of all railways require a regular supply, which must be obtained from some source,—not to speak of the stocks of many roads popularly credited with having absorbed more water than has been good for the stockholders. In view of these facts, the desire for an increased supply is entirely intelligible and justifiable. That a railroad company should be willing to spend money upon a process whose details are kept secret, and whose rationale (?) is unexplained, is without precedent. *Engineering News* (Feb. 14), rightly "conceiving it to be the office of a technical journal to publish information upon all subjects of technical interest, together with such comment as may aid its readers to clearly understand their significance," whether they be "fakes or otherwise," prints an account of the experiments and of the apparatus used on the road named, and also an editorial on the subject, which reviews the futile attempts at rain-making made by General Dyer on the plains of Texas, and the fallacy of the belief that led to them, and also indicates the "fake" character of the experiments on the railway above named.

The system (?) used is the device of one M. C. B. Jewell of Goodland, Kansas. Mr. Jewell has communicated to *Engineering News* an account of his apparatus. The method consists in injecting into the air a gas, or rather a mixture of gases, the nature of which Mr. Jewell keeps a profound secret. This is what he says in the communication referred to.

"The laboratory used in the field is a freight car, at one end of which three pipes project up through the roof. Each of these pipes divides into two pipes just inside the car, and the six pipes connect with six jars in which the gases are made." The letter continues: "On the opposite side of the car is a long shelf, on and under which we keep our materials. Directly over this shelf is a second shelf divided into thirteen compartments, in which rests our battery. At the end of the battery there is a large jug which is filled with a solution and is connected with the battery, which is also connected with the six large jars in which we make the gases. The tank on the top of the car is filled with water. This water we prepare before using, making it as soft as possible. The pipe near the left end of the car runs from the sink inside to a large hole dug in the ground to hold the waste. Sometimes this pipe is used as a ground connection from the battery. The other end of the car is partitioned off, and is used for a sleeping-apartment and office. My entire time is taken up while on the road answering correspondence, which comes from all parts of the world, and attending to the ma-

chine, which is operated day and night. I have used this process on the line of this road for two seasons. Last year I had three cars just like the one I send you a photograph of, and expect to have several more this year. Had there not been such hard times, several of the railroads in the arid regions would have used my process in 1894. My materials are furnished in Chicago by several different houses, and neither house knows what the other house furnishes, or which the other houses are. The men who operate the cars for me do not know what they are using, but simply follow my instructions. My process has been used sixty-six times, and at no time have I failed to produce rain; but at four places the rains were mere sprinkles, and were termed failures, and, to save argument, were so admitted by me. These failures are due to very high and changeable winds. There are no phenomena connected with these artificial rains any more than with a natural rain. All we do is to bring about the same conditions (?) which nature does when rain is produced, and, when we do this, a natural rain will fall. Nature and her laws are never wrong, and all efforts in this line must be in accordance with the laws of nature, or failure must follow."

Mr. J. B. Bailey of Phillipsburg, Kansas, writes to our contemporary with reference to experiments made at that place two years ago. "We were suffering for want of moisture, and I made application to our official department to have rain-maker Jewell come here and make a test. At about 2 p. m. he commenced operations. The skies were cloudless, and at about 5 p. m. the clouds began to appear, and at 9 p m. we had a rainfall of 0.78 in., as shown by the government gage. This included his first test at this point. The second test was followed by better results, there being a precipitation of 1 in. of rain. In the spring of 1894 we had him here again; the weather was cool, and the experiment was not a success, which I firmly believe was due to the unfavorable weather. The last experiment was conducted by H. Hutchinson, one of Mr. Jewell's substitutes, and who is not well versed in the science of electricity, which is an essential factor in tests of this nature. There is one point in your letter which I failed to answer, and that was the territory over which the rainfall extended. I would call it a local rain, as it did not extend over a radius exceeding 30 miles."

Mr. Whittemore of Belleville, Kansas, also writes: "Mr. Jewell gave us a fine shower in, I think, three days. He stationed one car at Mankato, one here, and one at Beatrice, Neb. We had a heavy rain from east of Beatrice to west of Mankato,—about 60 miles. I do not remember what the fall of water was, but I think it was 3½ in. I have all confidence in Mr. Jewell's power to produce rain." The broad and generous character of human credulity is, perhaps, as well exemplified in the acceptance of rain-makers' theories as in the facility with which any other humbug can gain supporters.

Wellner's Sail-Wheel Flying Machine.

AN article having the above title, by Helene Bonfort, in *Popular Science Monthly* for March, would have been better entitled "Modern Progress in Aeronautics," since only about one-third of it deals with Wellner's device, and the remainder discusses the general principles of flight, describes an apparatus entirely distinct from Wellner's and not even analogous to it, and briefly considers the work of the most distinguished investigators from the era of Gifford up to that of Lillenthal, Maxim, and Prof. Langley. However, the invention of Prof. G. Wellner of Brunn, Moravia, is the prominent feature of the paper. This is illustrated by engravings. It is described as follows:

"The essence of Prof. Wellner's innovation is his invention of the sail-wheel. It consists of a horizontally-placed axis, with spokes and arched aeroplanes attached to them in a cylindrical form. While revolving around the axis, the latter take a slightly slanting position, which causes the forward edges of these surfaces to be inclined, and consequently to compress the air in the way of a sail or a kite, calling into play the vertical force. Three ribs running across each lifting sur-

face and made in the form of a screw at the same time serve to strengthen the aeroplanes."

"These sail-wheels, set in pairs, can be placed, according to the size of air-ship aimed at, in one or more groups of two wheels, revolving in opposite directions, behind or beside each other. The cigar-shaped car, furnished with a motor and carrying the aeronauts, is attached horizontally under the center of the wheels, so that the whole construction will resemble a colossal bird, propelled, instead of by wings, by revolving wheels, the lifting surfaces of which are consecutively and constantly developing vertical and horizontal power. The bird's movements in flying and the speedy headway motion necessary to the kite-flying machines for their support in the air are, in Prof. Wellner's invention, changed to a rotary motion. This construction, while permitting of an easy, slow ascent, assures the horizontal position and constant stability of the air-ship, at the same time permitting of a high velocity. The more the latter is increased, the stronger is the lifting power developed. The direction is given by a rudder at the end of the ship, or by increasing the velocity of the sail-wheels on one side only. It is the peculiar quality of these wheels that they do not, as might be supposed, disperse the air around them; they rather attract it toward their rapidly-moving surfaces, condensing it to a powerful stream, which passes down obliquely through their cylinders. Their velocity can be made to surpass by far that of railway trains, thus enabling them to conquer contrary winds and air currents. This flying-machine will hardly be called upon to rise above the cloud region; it will reach its goal on an air line at a moderate height above the earth."

It is claimed that two "steam engines of 20 h. p. each will produce during one hundred and eighty rotations per minute a velocity of 45 meters, a soaring speed of 15 meters per second, and a carrying power of 1500 kilogrammes." It is also stated that "some eminent European aëronauts—Profs. Pistio, Miller, Hauenfels, and Wellner himself—now favor the principle of partial disburdening by the application of some gas or other, which will add to the lifting power of the machine. This may be well enough in the present state of the art; but any satisfactory solution of the problem of flight must ultimately include the power to rise and alight independently of any such aid.

Effect of Forest Removal Upon Climate.

IN "The Lesson of the Forest Fires," by Bela Hubbard, LL. D., in *Popular Science Monthly* for March, the author states that, though on some points scientists have not yet fully agreed, yet "the following propositions seem to be well established:

"(1) That the temperature is *hotter* in *summer* and *colder* in *winter* than when the country was covered with forests. This is a natural result of exposure of the soil to more active radiation and consequent frost. (2) The *winds have a more uninterrupted sweep*, and so the country is both dried up and refrigerated. (3) The *rainfall* is either *less in amount*, or its advantages are to a great degree lost. Forests retain the moisture that falls, and do not allow it to go to waste. (4) The *humus* in the soil, and the soil itself on the hills and slopes, are washed away by the rains, and carried to the lower lands and to the rivers, a large part being lost altogether." Abundant examples from the Old World might be adduced to fortify this position.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*29145. The Commercial Value of Weather Forecasts. E. B. Dunn(E Mag-April.) 2500 w.

29170. Heat Units. F. L. Slocum (A M & I W-Feb. 8.) 1300 w.

*29212. Peking. Thomas Child, with Discussion (J S A-Feb. 1.) 11500 w.

29275. New Jersey Clays: Their Classification and Adaptability to the Manufacture of Fire Brick. Charles Ferry (Ir Age-Feb. 14.) 1500 w.

29304. Compensation by Fees for Engineers. Editorial (E N-Feb. 14.) 1300 w.

29305. Can We Make It Rain? Editorial (E N-Feb. 14.) 1300 w.

We supply copies of these articles. See introductory.

29306. Rain Making on the Chicago, Rock Island and Pacific Railway (E N-Feb. 14.) 1400 w.

*29345. The Behavior of the Typhoid Bacillus and of the Bacillus Coli Communis in Potable Water. Dr. Percy Frankland (J G L-Feb. 5.) 4800 w.

†29364. The Financial Control of Government Engineers. Editorial (I Eng-Jan. 12.) 1200 w.

*29409. Argon, the Supposed New Element in the Atmosphere. Anon. (E R L-Feb. 8.) 600 w.

29439. Manual Training and Technical Education in Cleveland, O. Ill. E. P. Roberts (E W-Feb. 23.) 800 w.

*29461. Argon. (Eng L-Feb. 8.) 1600 w.

*29481. Argon. Editorial (N-Feb. 7.) 2300 w.

*29482. I. A New Constituent of the Atmosphere (Abstract). Lord Rayleigh. II. On the Spectra of Argon (Abstract). William Crookes. III. The Liquefaction and Solidification of Argon (Abstract). K. Olszewski (N-Feb .7.) 12000 w.

29494. Cold Storage and Cold Rooms from Compressed Air. G. D. Hiscox (Sc A S-Feb. 23.) 1500 w.

*29530. The Broader View. G. W. Dickie (S J E-Feb.) 3700 w.

*29594. Twenty-five Years of Geological Progress in Britain. Archibald Geikie (N-Feb. 14.) 3000 w.

†29687. Copper, Steel and Bank-Note Engraving. C. W. Dickinson, Jr. (P S M-March.) 7000 w.

†29689. The Scientific Work of Tyndall. Lord Rayleigh (P S M-March.) 4400 w.

†29715. The Appalachian Type of Folding in the White Mountain Range of Inyo County, California. Charles D. Wolcott (A J S-March.) 1400 w.

†29716. Notes on the Southern Ice Limit in Eastern Pennsylvania. Edward H. Williams (A J S-March.) 4800 w.

†29717. The Succession of Fossil Faunas at Springfield, Missouri. Steuart Weller (A J S-March.) 4200 w.

†29719. Drift Bowlders between the Mohawk and Susquehanna Rivers. Albert P. Brigham (A J S-March.) 5800 w.

*29799. Argon. J. H. Gladstone (N-Feb. 21.) 800 w.

*29809. An Engineering Laboratory for Glasgow University. Editorial (E-Feb. 22.) 1400 w.

*29811. The Competition in Coal. Editorial (F'y-Feb. 22.) 1500 w.

*29848. Village Communities in Southern India. C. Krishna Menon, with Discussion (J S A-Feb. 22.) 13500 w.

*29864. Marching Abreast in Science. From the English Mechanic (Inv-Feb. 23.) 2000 w

*29876. Philosophy of Wave Motion on Dams. E. R. Beardsley (Am M-March.) 1100 w.

†29918. Development of the Corallum in Favosites Forbesi. Variety Occidentalis. Ill. George H. Girty (A G-March.) 4000 w.

†29919. Early Protozoa. G. F. Matthew (A G-March.) 2200 w.

†29920. The Stratigraphic Base of the Taconic or Lower Cambrian. N. H. Winchell (A G-March.) 3500 w.

†29950. How to Organize the Union for Practical Progress in the Villages and Country Districts. Thomas E Will (A-March.) 6200 w.

†29951. Rubber Night at the Boot and Shoe Club (I R W-March 10.) 5000 w.

†29952. India-Rubber Horse-Shoe Pads. Ill. Gustave Heinsohn (I R W-March. 10.) 2300 w.

†29953. Why Rubber Tires Deteriorate. P. Carter Bell (I R W-March 10.) 1700 w.

†29954. Extraction of India-Rubber by Boiling (I R W-March 10.) 800 w.

Serials.

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng-Began Aug. 10—12 parts to date—30 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng-Began Oct. 13—Ended Feb. 16—9 parts—15 cts. each).

26996. Statically Indeterminate Structures and the Principle of Least Work. Ill. (E-Began Nov. 9—5 parts to date—30 cts. each).

27198. Refrigerating and Ice-Making (S E-Began Nov.—4 parts to date—15 cts. each).

27548. Constructive Engineering on the Pacific Coast. (I S F-Began Dec.—4 parts to date—30 cts. each).

28231. The Animal as a Prime Mover R. H. Thurston (J F I-Began Jan.—Ended March—3 parts—45 cts. each).

28263. The Handling of Men. Foster Crowell (E R-Began Jan. 5—Ended Feb. 16—4 parts—15 cts. each).

28427. An American Engineer's Observations in Europe. J. F. Flagg (E R-Began Jan. 12—2 parts to date—15 cts. each).

28862. Distribution of the Echinoderms of Northeastern America. A. E. Verrill (A J S-Began Feb.—Ended March—2 parts—45 cts. each).

29082. The Second Lake Algonquin. Frank Bursley Taylor (A G-Began Feb.—Ended March—2 parts—45 cts. each).

29229. On the Calculation of Frameworks with Superfluous Parts. Ill. Max am Ende (Eng L-Began Feb. 1—Ended Feb. 15—2 parts—30 cts. each).

29531. A History of the Last Quarter Century in the United States. Ill. (Sc M-Began March—1 part to date—30 cts).

COMMENT & CRITICISM

Friction of Belting and Shafting.

SEVERAL articles have appeared in the recent issues of THE ENGINEERING MAGAZINE upon the subject of transmitting power by means of electricity, and I have read all with very much interest.

The writers of these articles, as well as writers for other technical and trade periodicals, have made some statements which convey a wrong impression to the mind of the reader. In the Feb. issue Prof. Anthony says: "the loss by friction of shafting and belting is constant whether the machinery it is intended to drive is in use or not. The diagrams in connection with his article show that he has taken the friction load of the engine and transmission machinery to be equal to the power required to drive them when the machines which they are intended to drive are idle and to be no greater when all the machines are running.

In the table, quoted by both Messrs. Richmond and McKissick, Prof. J. J. Flather gives as the percentage of loss due to the shafting that power which is required to drive the shafting when the machines are idle.

From tests made by others, as well as from my own experience, I believe that I am justified in saying that these statements are incorrect, and that while there is a continual loss due to the shafting, the loss increases as the load on the machines increases and is greater when the machines are running than is shown by the table or diagrams.

The diagram which I send is from a test made by me of a 42" triple-geared lathe. The curve *A* shows the efficiency of the driving mechanism with the slowest back-gear and slowest cone-belt speed. From curve *A* we find that the power required to drive the mechanism itself when the torque on the spindle is 50,000 inch pounds is over one and one-half times greater than when the torque on the spindle is 6,000 inch pounds.

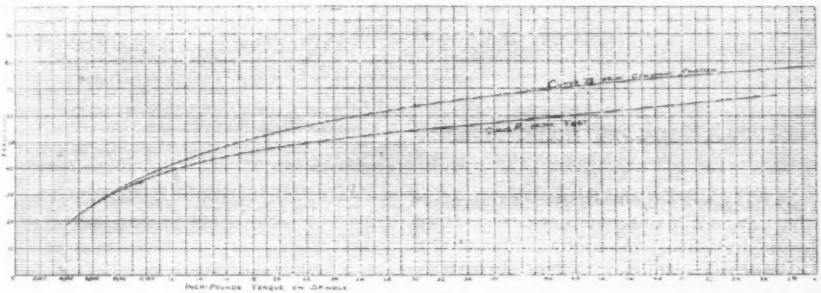


DIAGRAM. FRICTION OF SHAFTING AND BELTING.

For certain reasons it happened that a reading was not taken with no load on the spindle, so that the comparison is not quite as good as it might be. Assuming, however, that the friction load is constant, as these writers have stated, and that in this lathe it is the same as represented when the tongue is 6,000 inch pounds, we obtain the curve *B*. This shows that a much higher efficiency would have been obtained than was actually found to be the case.

In a paper read before the American Society of Mechanical Engineers, several years ago, on "Transmitting Power through

Belts" Mr. Wilfred Lewis says: "An interesting feature of these and subsequent experiments is the progressive increase in the sum of the belt tensions during an increase in load."

This would account for the increase of friction and power required to drive the transmitting mechanism, which I found to be the case in the tests that I made. The increase in the sum of the belt tensions causes increased bearing pressure and increased losses by friction.

Being a firm believer in the economy and convenience of using electricity for transmitting power, and that belts and long lines of shafting should be discarded as rapidly as possible consistent with the circumstances in each case, I wish to add what I have here said to the arguments already made by others in favor of the electric motor.

DAN. C. WOODWARD.

Lynn, March 6, 1895.

Prof. Anthony's Reply to Mr. Woodward.

I HAVE just received the letter of Mr. Woodward, which you sent me for perusal and response. I see that my language quoted by Mr. Woodward does not express exactly what I had in mind. I meant that the friction losses, due to belting and shafting are continuous, not that they are invariable. This, in contradistinction to electrical transmission where almost the whole of the transmission losses ceases with the stopping of the machine.

I think, however, that my language, as Mr. Woodward understood it, is warranted as a general statement by the generally accepted facts as to the action of belting and shafting to be found in standard works. I have not the books by me, but am quite sure the statement is made in Rankine, and I know it is made in other works on machinery and belting, that, under ordinary conditions met with in practice, the pressure produced by a belt upon the journals is independent of the load, or nearly so, the tension of the slack side of the belt being diminished as much as that of the tight side is increased. Since the pressure on the journals is constant, the friction of shafting that continues to run when the load is off will be practically constant. The loss from the slipping of belts will increase with the load, but this should not be great if belts are properly proportioned to the power they have to transmit. The loss from the rigidity of the belt will vary but little with the load.

These results, arrived at by the accepted authorities on the subject, would warrant the general statement that the friction of all belting and shafting that continues to run when the load is off, is practically constant. Counter-shafting and belting that stop with the machines, represent a loss not accounted for by the indicator diagrams taken when machinery is stopped. This, as well as the loss due to continuously running shafting, would be saved in the case of direct driven machines, and where such counter-shafting and belting are present, the case is still more favorable to electric transmission than load diagrams taken like those given in my article, would show.

WM. A. ANTHONY.

New York, March 11, 1895.

Science vs. Nature.

WHILE the "boom" was on in Virginia a few years ago a well known mining engineer of Roanoke rode over to one of the border counties of Southwest Virginia to inspect and report upon a mineral property. Late one evening he rode up to a farm house and asked if he could get accommodations for the night. The grandmother of the household was the only person to be seen.

"Yes, I reckon we can put you somewhere; everybody's off ter meetin'; so ef you'll put yo' horse in the stable the children 'll feed it when they come."

After following her directions he returned to the house where the old lady asked him to "take a cheer and draw up nigh the fire."

She sat upon one side of a large open fireplace where a generous blaze was making a big tea-kettle hum. Presently she stopped knitting and asked abruptly "young man, what's yo' business?"

"I'm a mining man, mam; I look after

mines and into mineral deposits and things like that."

"Minerals? well, you've come to the right place, cert'n."

"Indeed, I am glad to know it, I suppose you know of mineral deposits in this locality?"

"No, I cain't say as I do, but God knows there ain't nothin' much on the *outside* of these here hills, so there must be somethin' on the *inside*, and, young man, don't yer know I think the flood must have been some'ers 'bout here?"

"What makes you think so, madam?"

"Because there was mo' water them days, and it washed the dirt off'n the hills."

"No, no madam, the flood was purely of local origin, and there is just as much water now as there was then, there is no loss of water on the earth, you know."

"No loss of water? Young man, do you mean to say that when that tea-kittle's filled with water and it all biles away that there's jes' as much water lef' as was befo'?"

"Yes'm, it is simply turned into steam; it is in the air where—"

"Do you mean to say that when Sallie takes er bucket er water and scrubs up this here flo', that there's jes' as much water as ever?"

"No, not that exactly, only the floor has absorbed it, and that in time it will evaporate into the air where—"

Just then the young people came bustling in from the meeting, and shortly afterwards they all sat down to the supper table where the engineer had the grandmother opposite him. She sat in perfect silence for some time watching him narrowly over her glasses till suddenly she startled the other members of the family with:

"*Young man, you're the bigges' liar I ever see.*"

R. A. MARR.

Aluminum, the Superabundant Metal.

WE have read with much interest the article in the December number of the ENGINEERING MAGAZINE on the above subject, and written by Mr. Henry Wurtz, Ph. D.

We cannot quite agree with this gentleman's statements that ultimately other clays will supplant bauxite. What will, however, be done, is the adoption of a more recent patent than that of the electrolysis process for the manufacture of aluminum. Aluminum will be made in this country, or in Ireland, by a process of fusion, and at considerably less cost than can be done by the electrolysis process. We know this from the fact that we have control of the largest bauxite producing mines in Ireland close to a point of shipment where there is plenty of water and cheap tonnage. Aluminum metal will be made from our Irish Hill bauxite very shortly at a very considerably reduced price that will beat all competition.

GEO. G. BLACKWELL, SONS & CO.
Liverpool, Eng.

A Definite Correction.

IN looking over the February, 1895, number of your magazine, we observe that on page 933 you give an extract of a paper in regard to water tube boilers for marine use, in which the Babcock & Wilcox boiler is classed among the bent tube boilers. This is a mistake, and we are indebted to you for your remark indicating that such classification was probably an inadvertence.

We will now ask you to make a definite correction in your next issue. We use nothing but straight tubes, open from end to end for purposes of cleaning both inside and out, and naturally we do not want to be classed with boilers made up on the macaroni style.

THE BABCOCK & WILCOX CO.
New York, March 18, 1895.

NEW BOOKS OF THE MONTH

ELECTRICAL BOATS AND NAVIGATION. By THOMAS Commerford Martin, Past President American Institute Electrical Engineers, and Editor of the Electrical Engineer, and Joseph Sachs, Member the N. Y. Electrical Society, and Associate Member A. I. E. E. New York: C. C. Shelley, Publisher, 1894. [8vo., 224 pp. Price, $2.50.]

ELECTRICAL navigation is yet in its early infancy, but much good experimental work has been done, and a considerable measure of success has been attained, especially with the smaller class of boats, such as electrical launches, &c. The author has endeavored to bring together the typical data relating to the art, and he claims to have gathered much information not hitherto published. A historical account is given in the first chapter, in which is also considered the subject of boats propelled by primary batteries. In the second chapter the subject of storage-battery boats is taken up, and in the final chapter, in addition to what is said of storage batteries in the first and second chapters, much information of general value, which of course is also of special value in the electrical propulsion of boats, is given. Thus the difference of conditions between the use of storage batteries on boats and on tramway cars is pointed out in a clear manner, illustrating some of the difficulties which have been encountered in the application of storage batteries to the purposes of propulsion, and showing that these are much less in the electrical propulsion of boats than they can possibly ever be on tramways. The use of storage batteries is shown to have become more and more absolute for purposes of propulsion, and the conditions for the successful use of the storage battery are well indicated. The work is profusely illustrated with many examples of practice in electrical propulsion, and the subject of dirigible electric torpedoes for warfare and life-saving is treated in a chapter by itself. The same may be said of the subject of electric submarine torpedo boats. Special features of storage launch operation and charging are the subject of another chapter. One of the most interesting chapters is devoted entirely to special electrical craft, rowboats, catamarans, and paddle-wheel boats. The authors acknowledge in the preface the assistance of Mr. J. C. Chamberlain, Mr. F. Reckenzaun, and Mr. Joseph Wetzler in the preparation of the work. In our judgment this book is destined to have a wide circulation, especially among electrical engineers and marine engineers.

MENTAL DEVELOPMENT IN THE CHILD AND THE RACE. Methods and Process. By James Mark Baldwin, M. A., Ph. D., Stuart Professor of Psychology in Princeton University, Author of "Handbook of Psychology," "Elements of Psychology," and Co-Editor of the *Psychological Review*. With 17 figures and 10 tables. New York and London: Macmillan & Co., 1895. [496 pp., 5″¾×7¾″, Cloth, Price $2.60.]

THE subject of mental development in the child and the race is very thoroughly treated in the light of modern science. Infant psychology and race psychology are treated, the one from the genetic point of view and the other with reference to the characteristic mental peculiarities of various peoples, tribes, stages of civilization, cults, etc. A feature of the author's treatment is the attention paid to experimental data obtained directly from observations of infants from the earliest age through their development to adult age. Though the scientific method is pursued throughout, no intelligent reader would have any difficulty in comprehending all the principles and expositions comprised in the dissertation.

NOTES ON RANKINE'S CIVIL ENGINEERING, AFTER THE Notes of Professors William Allan and G. W. C. Lee. By David C. Humphreys, C. E., Professor of Applied Mathematics, Washington and Lee University, Member of the Am. Soc. C. E., etc. Lexington, Virginia, 1894, 19th Edition. [184 pp., 9″×13¾″, Cloth, Price $4, post-paid. Sold by the author, Lexington, Virginia, and Charles Scribner's Sons, New York.]

CONSIDERING Rankine's "Civil Engineering" as the standard, an effort is made in this book to increase its popularity by the addition of these notes. Rankine's book is more of a manual than a text-book. Equa-

tions and formulæ are frequently employed without any demonstration of the manner in which they are obtained. The notes supplied by Professor Humphreys show the reasoning from which the equations are derived, and will enable Rankine's excellent treatise to be read and used with far greater satisfaction than it can be used in the form given to it by its eminent author.

STEAM AND THE MARINE STEAM ENGINE. By JOHN Yeo, Fleet Engineer Royal Navy, Fellow of the Royal School of Naval Architecture and Marine Engineering, Member of the Institution of Naval Architects, etc. London and New York: Macmillan & Co., 1894. [196 pp., 5½″ × 8¼″. Price $2 50.]

A CONDENSATION from lecture notes of Prof. Yeo, in which a sound general view of the subject, with as much detail as is thought necessary for the end in view, is conveyed in a brief and simple manner. The book is well up to date, including descriptions of the most modern steam engines and boilers employed for marine purposes.

ELECTRICAL ENGINEERING FOR ELECTRIC LIGHT ARTISANS and Students. (Embracing those branches prescribed in the syllabus issued by the city and Guild's Technical Institute.) By W. Slingo and A. Brooker. With 346 illustrations. New and revised edition. London: Longmans Green & Co., and New York, 1895. [753 pp., 5″×7¾″. Price $3.50.]

THE original treatise of Slingo and Brooker on electrical engineering was justly regarded at the time it appeared as among the best ever published. To those who are familiar with that work and who have learned its value by use, it is enough to know, with reference to this edition, that it has been revised and brought up to date by the same authors.

A TEXT-BOOK OF VOLUMETRIC ANALYSIS, WITH SPECIAL reference to the Volumetric process of the Pharmacopœia of the United States designed for the use of Pharmacists and Pharmaceutical students. By Henry W. Schimpf, Professor of Inorganic Chemistry in the Brooklyn College of Pharmacy, Food Inspector of the Department of Health of the City of Brooklyn, etc., etc. First edition. New York: John Wiley & Sons, 1894. [400 pp., 5″×7½″. Price $2.50.]

"SPECIALLY adapted for the use of Pharmacists" means that the book is also well adapted to use for anyone desiring to become familiar with the principles of volumetric analysis. Chapter 14, on the "Sanitary Analysis of Water," is a complete epitome of this subject, and will be useful to sanitary engineers. Many superintendents of industrial works who are required to know something of chemistry as well as engineering will find this work useful.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Baker & Co., Newark, N. J., U. S. A.=Pamphlet and Catalogue, 38 p. [Considerably enlarged edition, containing information relative to platinum and its uses, with numerous cuts of platinum utensils and apparatus for metallurgical work. Also tables giving weights per foot of platinum wire in troy and French weights, with rules for determining the weights of corresponding sizes of wire in pure silver; wire gages; and a table of comparison of troy, Avoirdupois, and French weights. On the cover is an illustration of the gold, silver, and platinum refinery of the firm.]

Detroit Dry Dock Co., Detroit, Mich., U. S. A.=Pamphlet, 25 p. [Describes the performance of the steel steamer Harvey H. Brown, constructed by the company, in which, it is claimed, a cent's worth of fuel has transported a ton of cargo 170 miles at the rate of 13.2 miles per hour, as a result of Howdem's Hot Draft System. Also a mention of the saving of 33⅓% in fuel resulting from this system on the passenger-steamer Virginia; 6 full-page plates of indicator diagrams and two full-page tables of general results illustrate the text.]

Metropolitan Electric Co., Chicago, Ill., U. S. A.=(1) Street Railway Catalogue, 204 p., exclusive of cover. [An elegantly printed book, the contents of which require for their index a space of four closely-printed pages; cover, French gray and gilt. Comprehends substantially everything comprised in electric street railroading). (2) Pocket Catalogue of Insulators, 34 p. (Chrome lithograph engravings, with names and sizes.]

The Packard Family, New York & Ohio Co., Warren, Ohio, U. S. A.=Catalogue, 39 p. [Describes a full line of Packard incandescent lamps, both for high and low voltage, reflectors, sockets, street fixtures, transformers, and the Packard vacuum pump. Flexible cover, yellow and gilt.]

Keuffel & Esser Co.=Catalogue, 404 p. [Twenty-sixth edition re-written and revised and enlarged by more than 100 pages. Describes and illustrates one of the most extensive lines of drawing materials, drawing instruments, surveying and engineering instruments, carried by any firm in America. Also contains a great amount of explanatory matter relating to drawing materials and instruments, and to instruments used by engineers in general, such as planimeters, surveying instruments, verniers, leveling rods, aneroids and their use, field glasses, etc. Also contains half-tone views from photographs of the several departments of the store and factories of this firm.]

The Consolidated Telephone Construction and Maintenance Co., Limited, London, E. C., Eng.=Catalogue and Price List, 72 p., [Illustrates and describes the Consolidated Magneto-Telephone in its various forms, specially adapted for use in remote districts, and for desks; the Gower-Bell Telephone with vibrating bell, also with Gower-Bell transmitter and with bell-receivers; the Gower-Bell for separate vibrating bell; the Gower-Bell telephone with Hunning's transmitter for railway service; battery bell combination with Blake's or Hunning's transmitter; Hunning's transmitter on switch bell with receiver and cord; the consolidated battery telephone; the operators' telephone, containing receiver, transmitter, and circuit-closing key,—claimed to be the smallest key-instrument yet produced; domestic telephone; the Fitzgerald combination; granulated carbon transmitter and receiver, pencil transmitter, annunciators, switch-board, magneto call and extension bells, switches, push-buttons, lightning arresters, batteries, cords, tools, &c.]

The Goulds Manufacturing Co., 16 Murray St., New York, U. S. A =Catalogue of Pumps and Hydraulic Machinery, illustrating and describing efficient power pumps for every variety of service. 96 p. [An important feature of this catalogue is its descriptions and illustrations of pumps driven by electric power. Elegantly printed on coated paper; cover, lemon yellow, blue, and gold.]

Sherwood Manufacturing Co, 34 and 36 Washington Street, Buffalo, New York, U. S. A.=Catalogue, 24 large octavo p. [Describing the indicators, lubricators, engine and boiler supplies manufactured by this company. A unique feature among these descriptions is a water pressure ejector or cellar drainer, worked by water pressure, which is claimed to eject double the quantity of water that it takes to run it, and can be used to advantage in excavations, cellars, &c., where water pressure can be had, and the elevation required is not too high for the pressure obtained. A large variety of steam appliances are included in the catalogue, with price lists.]

The Walker Mfg. Co., Cleveland, Ohio, U. S. A.=Suggestions, Rules, and Tables on Electric Railway Work. [Pocket size; 37 printed pages, with blank pages for memoranda, and containing convenient data and tables.]

Ohio Brass & Iron Manufacturing Co., Cleveland, Ohio, U. S. A.=Catalogue, 1894. 52 pp., 5½″×7¼″. [Illustrates and describes the line of high-grade plumbers' brass goods, and the "Ohio Stops" manufactured by this company.]

The O. S. Kelly Co., Springfield, Ohio, U. S. A.=Portfolio, of engravings, 31 pp., 12″×16″. [Showing the Springfield steam road roller manufactured by this company, in the hands of its users, making all kinds of roads throughout the United States; also containing full detailed description of its construction. This is one of the finest trade publications received during the month. It is elegantly bound in salmon colored and gold cover, and the engravings are of unusual elegance both in their execution and arrangement. Important information relative to road rolling is also supplied in the text.]

Penberthy Injector Company, Detroit, Mich., U. S. A.=Catalogue, 35 pp., 9″×6″. [Describes and illustrates the Penberthy automatic injector, with other steam specialties manufactured by this company, and also contains descriptions and price lists of a number of new water gages and oil cups, which this company are just placing on the market. The entire catalogue is printed in green on lemon yellow paper, and presents a beautiful appearance.]

J. H. Sternbergh & Son, Reading, Penn'a, U. S. A.=Catalogue 1895, 51 pp., 5½″×8″. [Describes and illustrates the extensive line of bolts, nuts, washers, boiler rivets, bridge and ship rivets, lag-screws, turn-buckles, Harvey patent grip thread track bolts, soft steel bolts with cold pressed threads, rods and irons for bridges and buildings, etc., manufactured by this firm at Reading, and in the works of their branch establishment, the Kansas City Bolt and Nut Co., Kansas City, Mo. A frontispiece gives a view of the works. Price lists are included, which also give U. S. standard sizes. A list of sizes of merchant bar iron made in the rolling department of the works, and for which prices will be quoted on application, is also presented. Tables of sizes and proportions of the U. S. Standard Screw Threads and Nuts, dimensions of bolt heads, weights, etc., are appended.]

The Bradley Pulverizer Co., Boston, Mass., U. S. A.=Pamphlet, 27 pp., 9¼ × 6½″. [Describes and illustrates "The Griffin Mill," for the reduction of rock and ores of all kinds to fine powder. Adds also specifications for 38″ mill and an illustrated list of parts of the Griffin mill. 10 pages of testimonials are appended.]

W. E. Caldwell Co., Louisville, Ky., U. S. A.=Catalogue, 24 pp., 6″ × 9″. [Describes and illustrates the line of water tanks and iron water towers for railway and other purposes manufactured by this company, with price list. Also contains tables for computing the capacities of tanks and the strength of iron towers for supporting same. Details of construction are also given.]

The A. A. Griffing Iron Co, Jersey City, N. J., U. S. A.=Catalogue, 234 pp., 8″×5½″. [Describes and illustrates the various styles of Bundy radiators for steam or hot water, and a long line of heating specialties manufactured by this company, with price lists. The catalogue is nicely printed and bound in two styles, one flexible with cream, carmine and gold cover, and the other stiff cloth cover.]

W. H. Drake, Hackettstown, N. J., U. S. A. =Catalogue, 24 pp., 9″×6″. [Describes and illustrates the "Torrid" steam and hot water heater, with a list of parties who have these heaters in use, and a table of dimensions, heating power and price list.]

The Pennsylvania Brass Works, Erie, Penn'a, U. S. A.=Catalogue, No. 2, 1895, 16 pp., 6½″ ×5¼″. [Describes and illustrates a line of whistle valves, air cocks, steam cocks, water gages, gage cocks, engine and boiler lubricators, brass oil cups, and other steam goods. Also a line of plain brass church decorations. Beautifully printed in blue on glazed paper, with cream and carmine cover.]